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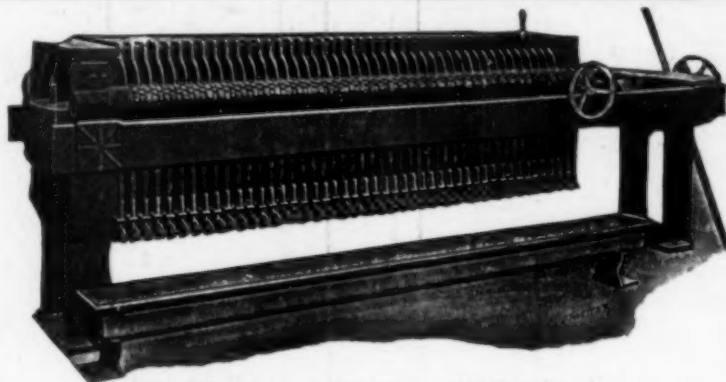
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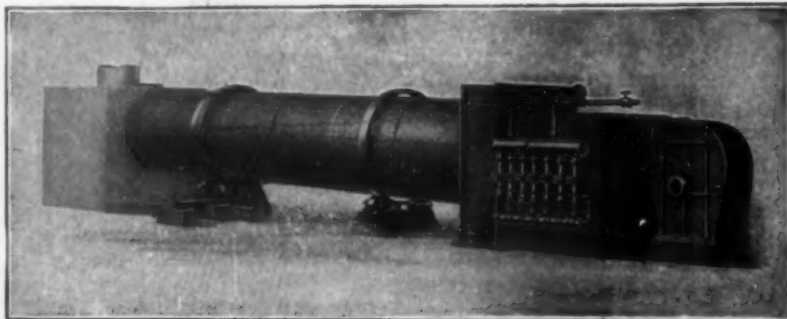
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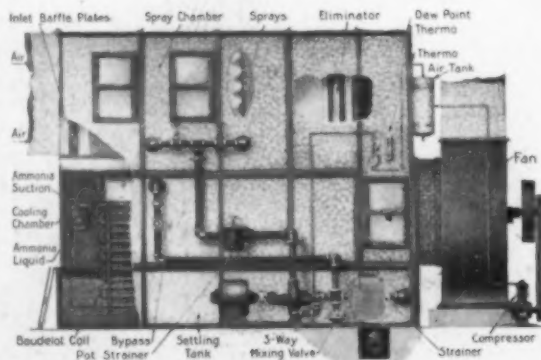
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A consolidation of ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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A Penalty on Western Residence

ANNOUNCEMENT is made elsewhere in this issue of the increased postage that must be charged to Western subscribers of CHEMICAL & METALLURGICAL ENGINEERING beginning July 1, 1919. This extra charge is the consequence of an act of Congress which practically penalizes those inhabitants of the United States who happen or prefer to reside far from the great publishing centers of the East. The more distant the residence, the greater the penalty.

When Congress was casting about during the war for sources of revenue, in desperation and ignorance it laid the axe to the root of the great publishing business and instituted a zone system on second-class postage, under which the national magazines are carried to all parts of the country. The system provides for increased postage varying directly with the distance from the point of publication; and inasmuch as the great publishing centers of the country are mainly in the East, it follows that Western subscribers are made to bear an inequitable burden. The country is sectionalized and a barrier is raised against the uniform dissemination of knowledge and information. The greatest force in the country for molding public opinion and creating solidarity of the people is thus handicapped in its efforts, and a part of the nation is the object of discrimination.

As we have remarked on former occasions, Congress does some things well, but revenue-raising is not one of them. The egregious folly of sectionalizing the country in a matter of postage is sufficiently apparent to the simplest mind that is open to conviction, and it would seem unnecessary to marshal arguments against a tax on literacy, intelligence and desire for knowledge. The publishing business of the country is ready to bear its just share of taxation for the support of the nation, and has gladly participated in all forms of revenue-raising proposed by the Government since the war began; but it is unable to see why, under the guise of taxing publications, the burden should be laid on subscribers in accordance with their place of abode. It would be interesting to hear the reply of a Congressman to this question. It might be illuminating if an Oregon subscriber to this journal should ask his Congressman why he will be obliged to pay nearly \$3 per year postage in 1921, while his more fortunate friend in New Jersey may have the same service for only sixty-eight cents. Oregon is a delightful State in which to live, but if it is cut off from participation in national enterprise and progress, it must inevitably retrograde and lose prestige as a desirable place of abode.

When the zone system went into effect, July 1, 1918, the publishers of this journal decided to absorb the first increase, and spare the subscriber the burden in the hope that Congress would repeal the law. It must be obvious, however, that this cannot continue indefinitely,

since the tax really is not on the publishing business but on subscribers depending on their residence. With the incidence of the second increase, therefore, the publishers are going to make a temporary compromise and pass the tax on to those subscribers living west of the Mississippi River. Renewed efforts are to be made to enlighten Congress, and hope is not yet abandoned that we will be successful. If we are, the charge for extra postage will be removed; if not, it must ultimately be distributed strictly in accordance with the rates established by law. In the meantime it is inconceivable that Western subscribers to this and other national magazines will refrain from voicing their views to their Congressmen; and it is equally certain that Congressmen properly approached will give heed to the combined voice of their constituency. Congressmen sometimes appear to be reasonable or unreasonable according as their political fortunes are affected. Once it is realized that the tax falls on subscribers and not on publishers we believe the light of reason will prevail.

The First Great Step

THE census of chemicals imported into the United States during the fiscal year 1913-14, prepared by the Bureau of Foreign and Domestic Commerce in collaboration with the American Chemical Society, is now ready for distribution. A digest of its features, with illustration of the manner of presentation, is given elsewhere in this issue. We commend a study of the pamphlet to every chemist of the country who has the welfare of his industry at heart. It may humble his pride, but that will do him no harm if it also stimulates his ambition.

This piece of work is the greatest single contribution ever made to the promotion of the chemical industry in the United States, for it shows in cold figures the extent of our pre-war chemical dependence on foreign countries. It stands as a monument to nearly five years of unremitting effort, and represents the co-operation of five departments of the Government—War, Treasury, Commerce, Agriculture and the Interior—besides numerous Federal boards and the American Chemical Society, which proposed and supported the plan. Never before has any Government done as much for the support of its chemical industry, and it remains to be seen what American chemists will do in response. The Government has met them more than half way, and the next move is theirs.

Let American chemists realize clearly what this census is. In effect it constitutes Exhibit A in the indictment of American chemical industry for indifferent dependence on foreign sources of crude and fine chemicals. While the achievement of its publication is a matter for congratulation, its content is in reality a measure of our country's humiliation when war revealed the appalling extent of our unpreparedness. Here, then, is no subject for rejoicing, but rather of sober meditation and firm resolution to alter the status of 1914.

It is well known now that when war dislocated world trade, the United States found that it had been dependent on Germany for a great quantity and variety of chemicals. We came to this realization over night, as it were, and a great cry arose throughout the country for chemical independence. There was much ado over the advantage our foreign neighbors had gained while

we slept, and there was a call for the chemical industry to awake. It is true that American chemists arose to the war emergency and acquitted themselves with credit. But the war is now over, the emergency is passed and the future is uncertain. Fortunately this census is published at an opportune time, for it will serve as a delicate reminder of the conditions of 1914, and an incentive to create a permanent well-rounded chemical industry in this country.

Do we really want chemical independence? The answer will be found in the extent to which we diminish the number of items in this census. If we are sincere in our pretensions we will undertake to manufacture those chemicals formerly imported, and do it in as great variety and quantity as possible. We will select not only those items which are plainly profitable, but will choose also those which are functionally and economically important if not financially remunerative. We will mix some patriotism with our brains and commercial enterprise, and carry a part of the load at little or no profit until we achieve that degree of profitable independence which must be our goal.

This census has been made for the good of the whole industry and not for private advantage and exploitation. The widest use must be made of it if we are to expect further governmental co-operation. The successful outcome of this work is an earnest of what can be accomplished by the chemists if the Government is convinced that the industry will profit by it. The machinery for continuing the work is in existence and the only possible excuse for failure to perpetuate it will be a lack of interest on the part of those for whom the work was done. The first great step toward American chemical independence has been taken. Will American chemical industry take the next?

The Chemical Foundation And Confiscated German Patents

THE Chemical Foundation has great potentialities, and we take it for granted from the high character of the gentlemen engaged in the organization that it has made no serious error in taking over substantially all German patents. Patents are property, and German-owned property is confiscate in this country. There is, or rather was, much more German-owned property in America than American-owned property in Germany, so that the balance is favorable.

With these postulates granted, the measure would appear to be ethically and prudentially sound, and we shall consider only two prudential features which we hope to see solved. We shall also make one unfavorable criticism.

A number of American leaders in industry conducted great manufacturing works in Germany. Owing to the proximity of European markets and better shipping facilities in former days from German ports, they conducted large export transactions from these branches. The present measure, which of course will be abundantly reciprocated, equips the Germans with a good start in the very lines of export trade that Americans have already built up, and in considering the future of American exports we must bear in mind an important loss from this source. The problem of adjustment will be difficult, although we are hopeful of its favorable solution.

A patent is a monopoly, and its original purpose was to encourage initiative in invention, but its usefulness

has extended beyond the inventor. Industry has developed so that economical manufacture is usually possible only on a large scale. And improvements are hard to introduce. To substitute a new article for one that is old and already produced in quantity involves, usually, a hard fight, and the cost of finding a market for a new thing, even though it is greatly desired, is expensive. Perhaps this should not be so, but it is. It comes from doing things on a large scale for purposes of economy in manufacture. Therefore, for the introduction of novelties a monopoly is almost necessary for a while, until the public is informed and the art of production is mastered. The present indefiniteness of the Chemical Foundation's licenses therefore detracts from their value. We understand that it is not the intention of the Foundation to grant licenses indiscriminately, to the encouragement of destructive competition, and we hope that in the definite plans of the organization this feature may be developed to the greater encouragement of licensees.

The administrators of the Chemical Foundation have a herculean task before them and it would be churlish indeed to heckle them in their deliberations. On one point, however, we think them open to complaint, and we do not hesitate to make it. In looking over the names of the directors we fail to find a single chemist in council. So far as we are aware there is not a man familiar with chemical industry to bring chemical understanding to bear upon its acts. This seems to us a proper ground for criticism, and with all good wishes we earnestly hope that the directors may soon correct the fault.

Readjustment

And Resumption

IT WAS said that the people awoke one fine morning in the early fall of 1879 to find the country prosperous. In 1899 there was a remarkable boom in practically all industries, especially marked in the iron and steel industry. There have been various arguments to account for what occurred in 1899. One cause advanced was that it was the even 20 years after the 1879 performance. Another that has been suggested, particularly by those who of late have been predicting good business because it always follows a war, is that the 1899 boom followed the Spanish-American war. Another, so ingeniously simple as to command admiration at least, was that it came after five years of industrial depression had resulted in all necessary adjustments being made. Some have even suggested that the 1899 boom was caused by the Dingley tariff of July 24, 1897.

Why could not the precise cause be assigned? The revival was largely psychological. Men got tired waiting. Conditions had become favorable some time before, but people were lethargic, unsanguine, pessimistic, hopeless. Much readjustment occurred in the years 1873 to 1876 inclusive, and in the years 1893 to 1896 inclusive, but very little in 1877 and 1878 or in 1897 and 1898. Things would have started sooner if men had not been in such a hopeless mental condition.

Today, however, we have no such unfavorable mental state. Men are hopeful, enthusiastic, anxious to get to work. The mental attitude is going to make them start too soon, if anything, certainly not too late. When these starts are made, they are made suddenly, as was the case in 1879 and in 1899. Perhaps the starts are not really sudden, but they appear so.

At the close of the war it was said that resumption of normal peace time activities would follow readjustment. That was so simple as to be quite elementary. No one undertook to inform us how far readjustment would have to extend in order that resumption could occur, hence we have been in the position of waiting for the resumption, in order to reach the interesting but useless conclusion that readjustment had been completed. It is like asking when the night will be over and being told that all we need to do is to wait until it is daylight and then we shall know that the night is past. Such information is strictly accurate but not particularly useful.

All that we have learned is that we cannot expect, as many did expect, a return to pre-war conditions as to wage rates or commodity prices. There has been enough pressure upon prices of many commodities, through restriction in demand, and upon wages, through unemployment, to cause a very considerable yielding if that were really in order, but there has been very little yielding. We cannot expect more in the second six months after the cessation of war work than has occurred in the first six months, hence the psychological phenomenon of men growing tired of waiting is likely to be exhibited almost any time. These things may come suddenly, as has been suggested by the instances cited, and particularly so when men are enthusiastic, as they must be when peace becomes established.

We have been indulging in various theories as to readjustment and reconstruction, and changing our theories as conditions changed and showed that they were unsound. No right theory for this period ever will be developed, because there is none applicable. We cannot generalize with so few facts. One theory that is about to be knocked out, if indeed it is not already knocked out, is that construction work cannot begin until construction costs are greatly reduced. We have been saying that several years of work have piled up and must be done, yet many have assumed that the work cannot begin until conditions have been made favorable for doing the whole collection of jobs. We could not do several years' work in six months anyhow, and certainly there is some work that is more pressing than others, work in which the saving of time adds a value. Some ventures are based upon a large annual return and a short amortization period, others promising smaller annual returns but admitting of a much longer amortization period in the accounting. Given a steadily descending scale of construction costs, month by month, the first named class of jobs would be undertaken sooner than the second. Again, there is work in which actual cost is not the sole consideration. One who invests in a work of construction simply to secure a profitable employment for his capital is in a different class from one who has a pet theory to carry out, or some other personal consideration. There is the man for instance who wishes a better house in which to live. His life is passing and he may not be disposed to defer building a new house for himself because there is a prospect that he would save a few dollars out of each hundred by waiting one year or two years of his life for his new house.

Resumption, therefore, is likely to come suddenly and without much warning, marking the end of the preliminary readjustment, furnishing the first definite disclosure of the amount of readjustment needed. Afterward from time to time there will be other readjustments, as it becomes necessary to pave the way for the less urgent work that is waiting to be done.

Readers' Views and Comments

Flaky Structures and Their Possible Elimination

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with much interest the excellent paper by Prof. Haakon Styri on "Flaky Structures and Their Possible Elimination" in your May 1 issue. There are a few facts regarding the thermodynamics of the equilibria of the oxides of iron and manganese at high temperatures which I would like briefly to discuss. The method used by Mr. Styri is so simple as possibly to appear to constitute an entirely rigid treatment to those readers not familiar with the subject. Nevertheless, those same facts which prevent the treatment from possessing even theoretical exactness have occupied the attention of physical chemists for a long time, without the accumulation of sufficient data, so far, to enable the correct theory to be put into practice. I refer particularly to the rôle of specific heats in the calculation of high temperature equilibria from ordinary thermochemical measurements at room temperature.

Some time ago I had occasion to examine the literature bearing on the question of the equilibrium in the deoxidation reaction $\text{FeO} + \text{Mn} \rightleftharpoons \text{Fe} + \text{MnO}$, which is, as evident, dependent upon two simple dissociation reactions, viz., $2\text{FeO} \rightleftharpoons 2\text{Fe} + \text{O}_2$ and $2\text{MnO} \rightleftharpoons 2\text{Mn} + \text{O}_2$. From an examination of the facts in the case it was concluded (1) that the existing specific heat data on iron, manganese and their oxides was insufficient to permit the calculation of these equilibria at high temperatures in even an approximate manner; (2) that there was no direct experimental proof that the above-mentioned deoxidizing reaction occurred, particularly in view of the existing doubt regarding the identity of ferrous oxide, FeO. Certain phases of this problem have been recently discussed by me elsewhere.¹

Mr Styri does not call attention in his paper to the fact that the use of the approximate form of the Clausius-Clapeyron equation connecting the dissociation pressure, the heat of reaction and the absolute temperature involves the assumption that the heat of reaction is independent of the temperature. This is equivalent to taking the mean specific heat of FeO and MnO in the temperature range considered (approx. 20 to 1600 deg. C.) as equal respectively to the sum of the specific heats of Fe and oxygen and of Mn and oxygen. Le Chatelier² first called attention to the fact that the constant of integration in the approximate form of the Clausius-Clapeyron equation, when the dissociation pressure is 1 atmosphere, is quite often in the neighborhood of 32 in the case of simple dissociation of a solid, but that it varies some 7 units in either direction. Forcand³ finds somewhat higher values. The subject is treated very thoroughly by Haber.⁴ The use of the value 32 by Mr. Styri is probably as good a guess as any, since in the case of the oxides Fe and Mn no really reliable data are available. Even in the case of the thermochemical values for the heats of formation of FeO and MnO there undoubtedly exist considerable errors. Since LeChatelier's measurements were made (about

1896) considerable advances in calorimetry have occurred.

On page 480, Mr. Styri writes down the equation

$$\frac{p}{P} = \frac{a^2}{A^2}$$

where p = partial oxygen pressure at a concentration of FeO equal to a , P = partial oxygen pressure for a saturated solution of FeO in Fe, and A = solubility of FeO. In other words, the ratio of the partial oxygen pressures for two different concentrations of FeO is equal to the ratio of the squares of the respective FeO concentrations, at constant temperature (equal to 1600 deg. C. in this case). The next step taken is a transformation of the above equation, thus,

$$p = \frac{P}{A^2} a^2$$

Mr. Styri substitutes in this equation the values of P and A already deduced by him, and, instead of replacing A by the value for the solubility of FeO, he uses the value for the "oxygen" content of FeO, thereby making it necessary to express a in terms of the latter. He suggests the analysis of steel for oxygen as a method of determining a . Recent work by the Bureau of Standards⁵ shows that the Ledebur method of determining "oxygen" in steel is of little practical value. This fact makes it certain not only that the actual oxygen content cannot be accurately determined by known methods, but also that LeChatelier's value for the solubility of FeO in steel, used by Mr. Styri in computing the constant A in the above equation, is nothing more at present than an admittedly inaccurate determination, with no intimation of how great an error may be involved. Taking into consideration all that has been said it is easy to see upon exactly what sort of experimental data the curves given in the chart on page 481 are based, and by what type of approximate theory they have been arrived at.

The danger which may result from the use of such a chart lies in the fact that, in view of its deduction from mathematical formulæ not fully understood by the average steel man, the conclusion may be drawn by such an individual that the physical chemistry of the deoxidation and allied processes is at present a complete chapter in our knowledge, thereby giving rise to an impression that further experimentation is mere repetition. As a matter of fact, what we actually know about the reaction $\text{FeO} = 2\text{Fe} + \text{O}_2$ is relatively little compared to what we do not know. The thermodynamics of the process is well known to all students of the subject. The mathematics of the case is easy compared with the difficulties of accurate measurements at these elevated temperatures. The sooner this important fact is fully realized and the necessary amount of labor given to the experimental side, the sooner will the science of metallurgy cease to be empirical and haphazard, and leap forward to its allotted position in the front rank of applied thermodynamics and physical chemistry.

This viewpoint seems reasonable when we consider the fact that at the present time our knowledge of the specific heat of iron extends only to 1100 deg. C.; and that of manganese to 500 deg. C.; while the data regard-

¹Journ., Ind. Eng. Chem., Vol. 11, p. 242 (1919).

²Ann. des Mines, Series VIII, Vol. 18, p. 157 (1888).

³Ann. Chem. Phys., Series VII, Vol. 38, pp. 384, 531 (1903).

⁴Thermodynamics of Technical Gas Reactions, 3rd Lecture, 1908.

⁵J. R. Cain and Earl Pettijohn, Tech. Paper 118 (1919).

⁶Phil. Mag., Vol. 10, p. 430 (1905).

⁷Ann. Phys. Chem., Series IV, Vol. 16, p. 551 (1905).

ing the specific heats of FeO and MnO are confined to measurements at room temperature. The specific heat of the common gases may be considered as fairly well established*, even at high temperatures.

Such data as do exist, for the lower temperature ranges, show clearly that the change in the specific heats of Fe and Mn may exert a relatively great effect in determining the equilibria at high temperatures. These changes cannot be ignored. For instance, Laemmel¹ finds that the specific heat of Mn at 0 deg. C. is equal to 0.1072; at 500 deg. C. it is equal to 0.1652, an increase of about 54 per cent. Who can predict what is its value at 1600 deg. C.?

To arrive at definite conclusions regarding these high temperature equilibria we must have data sufficient to make possible the use of the free energy equation in its complete form, or else succeed in making a direct determination of the equilibria. In the former case, we must have complete specific heat data, otherwise we are reduced to a state of unsubstantial assumptions and indefinite approximations. The latter solution, i.e., by direct measurement, appears extremely difficult but not entirely impossible. So far no one has attempted it in the cases under consideration.

Cleveland, Ohio.

ALEX. L. FEILD.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—It is sometimes an advantage, in order to raise discussion, not to treat a subject fully, and I am glad that Mr. Feild so strongly points out the necessity of determining the data we need for the accurate determination of the equilibria at higher temperatures. Besides the specific heat mentioned by Mr. Feild it is equally important to determine the oxygen and carbon content in equilibrium at higher temperatures and I agree that no known method for the determination of oxygen in the cold steel is satisfactory because no attention is paid to the oxygen which escapes during cooling and solidification. My statement of Pickard's analysis of 0.092 per cent O and of Shimer and Kichline's of 0.074 and 0.064 per cent O in overblown steel (by an error stated wrongly in my paper) as possibly representing the oxygen concentration in the steel for a certain slag should therefore be correspondingly modified.

In the writer's paper it was the intention to collect in as simple form as possible the influence of the different variables in steel refining. It might help others as it helped myself to get a clearer understanding of the reactions in the steel furnace and will aid in the prediction of what must happen to the steel when additions are made or the temperature changed. The value of determining the heat of combustion and the solubility of oxygen and carbon more accurately at the temperature considered will be to give the curves of my chart their correct position, which in all probability will be different from those presented, but the relative form of the curves must be the same. And even with great divergence from their correct values the curves will be useful in practice because we must remember that they represent equilibria and it will be in only extremely rare cases that such conditions are present in the steel furnace. Most of the time the conditions deviate considerably from the equilibria and we will correspondingly have different speed of reactions according to

how far the system is from equilibrium; and knowing the conditions we can predict in what direction they will go.

With the unsatisfactory knowledge of the saturation concentration of oxygen at different temperatures I found it unnecessary, therefore, to try to calculate the heat of combustion at the high temperature by the help of the inaccurate specific heats, and for the same reason I refrained from publishing some otherwise interesting calculations of the influence of different slag concentrations. It was the writer's desire first to determine in actual practice how much the calculated curves would vary from concentrations found under certain conditions in the steel furnace and if possible under equilibrium conditions, and also to try to determine certain physicochemical data whereby the problem could be attacked from another angle. Both series of tests were started before the paper was published, but I regret to say that the progress has not been fast owing to lack of opportunity and time.

Mr. Feild notes the substitution of the oxygen content of FeO for the solubility A of FeO in formula 6, thereby necessitating the expression of a in the same terms. It was perhaps a little careless not to retain the numerical value of the solubility of FeO and calculate the O content from the found concentrations of FeO (a). But it is easy to see that the concentrations of FeO (A and a) vary from the concentrations of O only by a constant factor, the same in numerator and denominator, so no misunderstanding should occur since the explanation was given in advance.

The concentrations of O can just as well be used in the formula, since we do not know in which form the O is present in the liquid steel, whether combined with Fe and dissolved as FeO or dissolved as O. It is clear that whichever form it is, the partial pressure of the O must be equal to the dissociation pressure of the FeO with which it is in equilibrium, when we disregard the probably small influence of the partial pressure of Fe.

HAARON STYRI.

Carnegie Institute of Technology,
Pittsburgh, Pa.

The Art of Searching Chemical Literature

To the Editor of Chemical & Metallurgical Engineering

SIR:—In connection with the article on "The Art of Searching Chemical Literature" in this issue of your journal, may I call the attention of the National Research Council and especially of the committee on publication presided over by Dr. Stieglitz, to the desirability of a publication which shall provide what might be called a "General Index to Chemical Literature"? This would include the "art of searching literature" and provide at the same time a full and complete list of all special monographs, theses and works of reference to chemistry.

The instructive synopses of chemical treatises published by Mr. McClellan in the bulletin of the Carnegie Library serve a very useful purpose, and if these were made to embrace the entire chemical literature they would provide a volume of especial value.

Another point of interest is that up to the present the French chemical journal literature has not been readily accessible largely on account of the lack of good indexing. It is easy to understand why German authors have invariably failed to give proper credit to French investigators, and if some one well qualified

*See Lewis, J. A. C. S., Vol. 34, p. 1128 (1912).

would undertake the general abstracting and indexing of this literature it would be of valuable assistance in promoting the advance of chemical knowledge and would serve to refute to a considerable extent the exaggerated claims of German chemists in many branches of the "art of chemistry."

The writer would also like to suggest to editors of scientific journals the advisability of printing on the outside cover of each issue the initial and final page numbers. By this means the necessity of having to glance through several issues could be avoided. Incidentally this is the scheme adopted by the *Chemisches Centralblatt*.

Mount Vernon, N. Y.

HAROLD HIBBERT.

Railroad Research Work

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your editorial in the issue for April 1, criticising the "complete cessation of industrial research and of the development of natural resources of the territories served by the various railways," now that the railroads are being administered by the Government, puts me in a reminiscent mood. I can write freely because I have practically retired from business and can possibly speak with some authority, as I was Railroad Industrial Development Commissioner for over twenty-five years. I originated the Railroad Industrial Department; ultimately it spread over the entire United States and has been more or less established on all continents.

I laid my plans before the management of the Chicago, Milwaukee & St. Paul Railway Co. in 1891. They were accepted, and with "We have no instructions to give, develop our territory," I started out on my mission. I had been trained in the transportation business and had a hobby for the study of political economy. I knew that the traffic and operating departments had their hands full with current business from morning until night and had little or no time for research. I resolved to take adequate time, and for the first six months did nothing but travel over the entire territory looking out of the car windows and acquainting myself with the people and resources of the line. Space forbids lengthy details. I will merely give a few instances showing general plan of operation.

Shortly after entering the service of the St. Paul I read in the newspapers that the pine had been largely cut out in several parts of Michigan, that once flourishing towns in the lumber districts were going to pieces and that substantial residences could be bought for \$5 apiece as salvage. We had similar pine territory in Wisconsin. Sawmills were more and more coming in, the railroad was doing an immense and profitable business hauling lumber, but I figured this could not last and in the end we would have a bonded streak of rust. This especially threatened the Wisconsin Valley Division, which parallels the Wisconsin River. This territory was practically one forest of hardwood, pine, hemlock and some spruce. The pine lands with standing timber were rapidly rising in price and selling on stumpage basis, that is, at so much per thousand feet of estimated timber on the land. The hardwood land was selling at \$3 per acre with the trees on it and the hemlock lands were almost unsalable at \$3 per acre, including the standing timber. I advertised for furniture, veneer, cooperage and kindred factories; went East and canvassed manufacturers to come West; aroused the local towns to invite such factories. They were secured;

the cities themselves did most of the work of securing new industries.

There were water-powers galore running to waste all along the Wisconsin River. Thomas Nash, Assistant Postmaster General, who lived at Grand Rapids, Wis., owned a water-power at Nekoosa, Wis. He told me he would put in the power as capital stock if I could get an Eastern paper manufacturer with capital to put in a paper mill. I advertised in all the paper-trade journals, went East and canvassed the manufacturers at Holyoke, Bangor and other places. Several came West to look the ground over. Nash heard what they had to say, but none of them would bite. Nash spoke to Ex-Postmaster General Vilas, a Wisconsin man. "What is the matter with us all chipping in and starting a paper mill ourselves?" said Vilas. They did. The second year the mill was paying the St. Paul road a freight bill of over \$85,000; it ultimately went over \$100,000 per annum. In eleven years we had eleven large paper mills on the Wisconsin River, chiefly from local capital. One city emulated the other; all I did was beat the drum.

I told our immigration agent to direct Scandinavian farmers to the cut-over hardwood lands, which were selling cheap. Hardwood stumps rot in two years. Settlers came. Pine stumps take 75 years to rot. I helped the powder companies to start dynamite squads to show owners of pine stump lands how to blow out the stumps. Then I took the hemlock lands in hand, advertised for tanneries in all the Eastern tanning sections, canvassed tanners and got a big Boston firm interested. They looked the ground over and shipped two cars of tanbark to Boston. Good! They located a large tannery at Merrill, Wis. After arranging for side-track there I took the train for Chicago. En route I met Mr. Nash on the train, told him I had just located a tannery at Merrill, the tanners had bought a large tract of hemlock, they would use the bark, but there being no present market for the wood it would go to waste. Not so! Said he, "Look here," showing me a paper, "we have just received our patent for making sulphite pulp from hemlock. See that I get a freight rate and I will contract for the peeled hemlock logs." We made him the rate and the logs went to the mill.

At another point because of distance the iron pyrites were unsalable. I canvassed the situation and we secured a sulphuric acid plant on the spot. Mineral, special clay and other finds were investigated, often with permanent freight results. But enough said. In 1903 I went to the Erie Railroad as Industrial Commissioner and we put new plants on that line in the next eleven years that would extend continuously on both sides of Broadway from the Battery to Spuyten Duyvil.

I believe that the Industrial Department of the Southern Railway did more for the development of the South than the Federal and State Governments combined, and so with all other railroads. I visited South America last year and found that two railroads there had Industrial Departments. I dash this off with no idea of self-laudation but merely from an interesting experience to confirm what you editorially intimate, namely, that the industrial development and research work of the railroads had its place, is creative and ought to be continued. I hold that whether the railroads are privately owned or government owned, creative departments are national wealth-producers.

LUIS JACKSON.

Upper Montclair, New Jersey.

The American Chemists' Responsibility

To the Editor of Chemical & Metallurgical Engineering

SIR:—The Bureau of Foreign and Domestic Commerce has just published a little pamphlet compiled by it in collaboration with the American Chemical Society. This marks a new and unique phase in co-operation between government agencies and our industries; it displays a wholesome spirit of practical patriotism and good citizenship born of war conditions and which must continue and grow in order that pre-war conditions of avoidable national dependence on foreign countries for things chemical may never return. The Government's labors are for the present concluded; the chemists' responsibilities have only now assumed tangible, definite and concrete form. Whether this country shall become and remain chemically as independent as possible now rests squarely upon America's chemists and not elsewhere.

The American public has declared in unmistakable manner its demand that this country be chemically independent; this pamphlet tells our chemists the name, the quantity and the value of every chemical article imported into this country in the fiscal year 1913-14 (the last peace-year) and also what proportions of each article came from the various countries supplying it. American chemists are therefore now and for the first time fully informed and in great detail concerning the nature and scope of their task. They know the individual articles, the domestic business volume of each, the unit price they have to meet in almost each case and the competing countries. The Chemical Foundation by acquiring all enemy-owned U. S. patents in these fields has made it possible for American chemists to surmount any obstacles to progress toward chemical independence offered by those patents. No matter how large an export or domestic business our chemists may hereafter build up, if they do not reduce America's avoidable chemical dependence they will not have met the thoroughly proper demand of our public. Progress in export or domestic business, no matter how great, never can offset any avoidable national chemical dependence.

The functional value of articles in our national activities must be the paramount guide in making us chemically independent; mere size or volume of business is no safe index of national importance. A few thousand dollars will supply all the optical glass in all the microscopes, binoculars and the like used in this country. A few hundred dollars worth of assorted coal-tar dyes will supply all the needs of the nation's bacteriologists. A few thousand dollars worth of assorted stabilizers will make the country's total requirements of explosives, in peace and in war, safe to handle and to transport. A few thousand dollars worth of assorted synthetic remedies will care for the needs of the nation's afflicted. Since foreigners succeeded in making us dependent on them for these things, it simply cannot be that our chemists cannot make us independent in those respects.

Yet the task thus concretely set American chemists is, from a business point of view, not an easy one. Three thousand separate articles of chemical manufacture and of national functional importance, but totalling only about \$60,000 in value, or \$20 per year on the average for each article, were imported in 1913-14; hundreds of like articles worth less than \$5,000 a year apiece were then imported. How can this business be profitably distributed over our many chemical factories without violation of our own long-standing laws? America's

chemists must solve not only the chemical details of production and application of these many items of manufacture but also the law-problems which obstruct progress. They can solve the former by themselves; whether they can afford to carry them out in competitive commercial practice or not depends upon their success in obtaining proper remedial legislation, and in this they must have sympathetic and effective co-operation from both the public and our law-makers; but the chemists must take and maintain firm and concrete initiative on both branches of this single problem; anything less than that is bound to lead to disappointment.

BERNHARD C. HESSE.

New York City.

Bucher Cyanide Process

To the Editor of Chemical & Metallurgical Engineering

SIR: In reporting the recent meeting of the American Chemical Society at Buffalo you state on page 394 that a paper on the Bucher Cyanide Process was given by R. O. E. Davis. This paper was by J. B. Ferguson of this Laboratory.

Geophysical Laboratory,
Washington, D. C.

ROBERT B. SOSMAN,
Acting Director.

Western Chemical and Metallurgical Field

Oxidized Copper Ores in Arizona

ONE reads in the annual reports of Arizonan corporations such statements as the following (Inspiration): "Oxide copper in mill feed, 0.291 per cent; oxide copper in mill tailings, 0.253 per cent." Such a condition of affairs has caused general interest in some method whereby this elusive portion of the ore may be saved at a profit, to say nothing of its obvious application to the enormous known deposits of oxidized mineral.

A judicious combination of flotation and gravity concentration is apparently capable of making excellent recoveries of copper sulphides even in low grade ores—it may be rather unfair to quote 88.51 per cent from the Inspiration report as a mark to aim at. Consequently considerable attention has been given to "sulphidizing flotation," where by means of various reagents the oxidized particles are changed superficially to sulphides to a sufficient extent that they may be picked up by the bubbles in a flotation cell. Such a scheme was used at Hurley in the Chino Copper Co.'s mill with considerable success during the latter part of 1917. Also at Superior, the Magma company has been conducting careful and large-scale experiments with good results on the flotation of its oxidized ores. Whether the ore at Superior is more amenable to sulphidizing flotation than the general run of Southwestern ores is a matter of question—it is probable, however, that general adoption of this process will await its perfection to the point where a little inattention or a little incompetency will not throw the entire system out of balance. In other words, the impression exists that sulphidizing flotation is a delicate process which cannot yet be trusted to the average mill man.

Leaching is the apparent alternative. The only commercial operation in Arizona is at Ajo, but the signal success of this well-designed plant has strongly attracted other men with like problems to solve. Sulphuric acid, the solvent used at Ajo, is comparatively cheap and

can usually be manufactured locally from pyritic ores, while methods of precipitating copper sulphates either by electric current or on iron are quite efficient and perfectly well known by many operators. In an ore-body such as that of the New Cornelia Co., whose major mineral content is oxidized, it is obviously good engineering to leach out the acid-soluble mineral from coarsely ground ore, then follow by fine grinding to release the cleaned sulphides for flotation and gravity concentration. Movement of leach and wash solutions by displacement is feasible on granular material such as at Ajo; with finely ground material discharged from a flotation cell, counter-current decantation methods would probably prove equally satisfactory.

However, such fine tailings containing considerable quantities of clay or other like substances as experimented on at Clifton by the Arizona Copper Co. may involve the addition of so much expensive wash water as to eliminate profits altogether from the leaching operation.

While sulphuric acid is a good solvent for copper, it also attacks many other constituents of an ore to a greater or less extent, with the result that the solutions will become quickly fouled, among other undesirable effects causing a heavy loss in acid. Fortunately, experiments on 10-ton lots of Inspiration ore show it to be extremely well adapted to treatment by the Ajo system; i.e., leaching out oxides, fine grinding the residue and then floating sulphides. Following that company's semi-laboratory experiments, a unit with 35 tons daily capacity is nearing completion wherein complete information as to eventual mill practice will be obtained.

Decision as to actual construction is halted to a large extent, however, awaiting the publication of the tests being made by the Miami Copper Co. in co-operation with the Bureau of Mines. An experimental plant of considerable size was built during 1918 and operated satisfactorily for some time at the end of the year. Indicated revisions and additions are now in process of installation.

Publication of the details of this process is withheld pending completion of the test and clarification of the patent situation; however, it is generally known that the process consists of digesting the pulp with roaster gases and precipitating the clarified solution on iron. Digestion may evidently precede, follow or separate flotation operations according to particular conditions.

Heap-leaching of partially oxidized ore and low-grade capping is also receiving considerable attention. Large-scale operations on old tailings and California Hill capping are under way at Bisbee, while a large heap is being built by the Chino Copper Co. Possibly the most careful experiment is by the Phelps-Dodge Corporation at Tyrone, New Mexico, where several piles of various tonnages, depths and stratification are under observation.

Generally such piles are to be leached with mine waters discharged from precipitation tanks or launders. This water contains considerable ferric sulphate, a moderate quantity of copper and may be slightly acidulated—it is distributed over the surface of the pile—and after percolation is drained off to a recovery system. Periods of leaching and oxidation alternate, much after the methods used for years on tailings piles and ore heaps in Montana and Rio Tinto.

Beet Sugar in Utah and Idaho

Beet-sugar production in Utah and Idaho was discussed by men prominent in the industry at the April meeting of the Utah Society of Engineers. Sugar has recently sprung into great prominence in the two states, there being at present 23 factories in operating order and two more in course of construction, representing an investment of approximately \$50,000,000, of largely local capital, this value being further augmented by agricultural land holdings, cattle and railroads. During the 1918 campaign about 2,750,000 bags of sugar (100 lb. each) was produced, valued at \$24,500,000. Items of approximate cost production follow:

Sugar beets, 1,250,000 tons.....	\$12,500,000
Coal, 160,000 tons.....	600,000
Lime rock, 100,000 tons.....	140,000
Coke, 12,500 tons.....	100,000
Bags, repairs, and miscellaneous items.....	1,750,000
Freight.....	1,250,000
Taxes.....	350,000
Payroll.....	3,500,000

Utah and Idaho factories are relatively small, having a cutting capacity of from 350 to 1200 tons of beets per day. As is possibly well known, sugar manufacture is not a complex operation; juices are extracted from the shredded beet, purified and evaporated, the sugar separated from molasses, then washed, dried and sacked. Chemical engineering problems are therefore confined largely to the handling of large quantities of hot solutions—which is almost universally done by closed impeller double-suction centrifugal pumps with a very deep stuffing box—and the evaporation of correspondingly huge volumes of water. Multiple-effect evaporators (3, 4, or 5-stage), with either vertical or horizontal tubes, are used for preliminary concentration, while crystallization is done in separate vacuum pans or candelaria. Naturally great attention is given to minimizing extraction- and wash-water and to boiler practice—sugar houses will have about 3 rated horsepower in tubular boilers capable of continuous large overload for each ten-day capacity. One pound of sugar requires from 0.9 to 1.3 lb. of bituminous coal for its manufacture, depending upon the efficiency of the thermal transfer and the sugar content of the beet.

Problems in industrial economy are dependent upon the fact that bulky beets should not be hauled great distances to a factory, on account of freight charges and the constant loss of sugar after digging. Small factories are therefore situated centrally in their contributing fields. Nine months out of the year the factory is closed and satisfactory part-time labor is rare during harvest time.

Sugar beets in proper quantity and quality represent the biggest problem of all. Here the factories are entirely dependent upon the farmers, and have only now awakened to the value of their good-will—or rather, the cost of their ill-will. Despite a large increase in price per ton paid the farmers, the sugar content is steadily falling to a dangerous minimum, while the shrinkage between wagon-scale and factory has nearly doubled in the last three years. For instance, whereas one of the larger Utah companies then received 6 per cent less beets than it paid for, last year it received about 11 per cent less. Doubtless a good share of this loss is due to natural shrinkage by evaporation of moisture and inversion of sugar by processes accompanying sprouting, still this particular company figured that it paid the farmers \$260,000 in 1918 for their ill-will, for unwar-

rantable shrinkage caused by practices best known to the farmer himself.

Certain difficulties attend the successful maintenance of a schedule with beet farmers similar to that imposed upon metal miners. Doubtless perfectly satisfactory sampling methods could be worked out so that the farmer could be paid for the sugar actually delivered in the beet, but experience proves the unpopularity of this sort of contract. Farmers are in a somewhat different position from miners—if the latter do not care to accept the smelter schedule, about the only thing they can do is pack up and move into some other work. On the other hand, if a farming community decides not to raise beets, it simply plants a kitchen garden, and raises hay or grain. In other words, the sugar factory can be starved much more quickly than can the farmer.

Because of such considerations, corporation officials are seriously attempting to mold sentiment in their favor by all possible means. Co-operative profit-sharing even appears in the distance.

Interallied Chemical Confederation

THROUGH the initiative of the Société de Chimie Industrielle, an interallied chemical meeting, composed of delegates from Belgium, France, Great Britain, Italy and the United States, was held in Paris April 14, 1919, for the purpose of organizing an interallied chemical confederation. The American delegates were: Mr. Henry Wigglesworth, chairman; Dr. F. G. Cottrell, representing the National Research Council and the American Electrochemical Society; Lt.-Col. Bartow, of the American Institute of Chemical Engineers; Messrs. John Pennie and Charles MacDowell, counselors at the Peace Conference; Lt.-Col. Zanetti, Lt.-Col. Norris, Major Colin MacKall, Lt. Sidney Kirkpatrick and Mr. Donald Riley, representing the American Chemical Society.

A number of private meetings were held, presided over by Prof. Charles Moureau, president of the French Federation of Chemical Associations, at which were adopted the articles and by-laws of the Interallied Chemical Confederation for a close co-operation among Belgium, France, Great Britain, Italy and the United States. The status among the different chemical associations of the allied countries was agreed upon, and provision made for the possibility of permitting neutral countries to belong to the confederation. An interallied council board was elected, and it has been decided that the next meeting shall be held in London July 15-18, 1919.

During the public meetings of April 14-15 the following subjects were presented:

Prof. Henry Louis (Great Britain) spoke on the enrichment of iron ores by magnetic separation. Dr. Cottrell (United States) outlined American progress in the work on helium. Prof. Moureau, who was the first in France to show the existence of the sources of helium, and Mr. Georges Claude, the author of works on liquified air, presented remarks on the possible uses of helium. Mr. MacDowell (United States) spoke on the development of the American potash industry. Mr. John C. Pennie (United States) dwelt on the American patent laws, and Mr. Barbet suggested the enacting of an interallied patent law. Mr. Otlet, director of the International Office of Bibliography, closed the

public meetings with an extremely interesting communication on the organization of the International Documentation.

After the customary dinners and after-dinner addresses the first interallied chemical meeting closed with a visit by the members to the devastated regions of Chauny.

The members of the council board who will meet in London next July are:

Belgium: Messrs. Chavanne and Crismer.

France: Messrs. Moureau and Paul Kestner.

Great Britain: Sir William Pope and Mr. Henry Louis.

Italy: Senator Paterno and Mr. Parodi-Delfino.

United States: Dr. Cottrell and Lt.-Col. Zanetti.

The general secretary is Mr. Jean Gerard, and the business address of the Confederation is 49, rue des Mathurins, Paris.

Chemical Exposition Plans

THE fifth annual National Exposition of Chemical Industries will be held this year in Chicago at the Coliseum and the First Regiment Armory during the week of Sept. 22, and as usual there will be a number of society meetings held jointly with it. The decision to hold the Exposition in Chicago was made unanimously by the advisory committee in consultation with the managers of the Exposition. One of the reasons for this change was the fact that the U. S. Army has commandeered Grand Central Palace for use as a hospital so that it would not be available for exposition purposes. Another reason was the keen interest shown in the Exposition by the Chicago section of the American Chemical Society, who felt that a Middle-West exposition would encourage development of the chemical industries in that part of the country. Indications are multiplying that the Exposition will be as successful as it was in New York, for all the space in the Coliseum and most of that in the Armory has been engaged.

A number of scientific and technical societies will meet in connection with the Exposition, among them being the American Institute of Mining and Metallurgical Engineers, American Electrochemical Society, American Ceramic Society and the Technical Association of the Pulp and Paper Industry. The Chicago section of the American Chemical Society will have headquarters at the Exposition and will probably hold a meeting. No other conventions will be held in Chicago that week so that adequate hotel accommodations will be available. The advisory committee and the managers of the Exposition are being assisted by a special Chicago committee consisting of Messrs. L. V. Redman, W. D. Richardson, A. V. H. Mory, Carl S. Minor, F. W. Willard and William Hoskins. The managers as in the past, are Charles F. Roth and Fred W. Payne, and the general office is at 477 South Dearborn St., Chicago, Ill.

Civil Service Examinations for Chemists

Catalytical Chemist, \$3000 to \$4000 a year; Assistant Catalytical Chemist, \$2000 to \$3000; Junior Catalytical Chemist, \$1600 to \$2000. Applicants for any of these positions, which are open to men only, must have had at least one year's experience in preparation and study of low temperature oxide gas catalysts.

On account of the needs of the service, applications will be received until further notice.

Spring Meeting of the New Jersey Chemical Society

IN spite of unfavorable weather about 100 members and guests of the Society met on May 10 at Rutgers College. The grounds, buildings and laboratories were inspected during the afternoon and dinner was served in Winants Hall in the evening. Prof. Ralph G. Wright, chairman of the entertainment committee, welcomed the members on behalf of the college and Johnson & Johnson, manufacturing chemists, of New Brunswick, who joined in entertaining the Society. Appropriate response was made by President Carleton Ellis. At the evening session a paper was read by Lieut. Joseph V. Meigs on the stability of automobile engine oils. By means of six well prepared experiments he showed the variation in the reaction when sulphur chloride is added to engine oils of various grades. He showed that medicinal mineral oil, being a highly refined product, reacted much more slowly than did other oils used for engine purposes. Turning to the lighter side of this subject, Lieut. Meigs said that it would be well if chemists would stand by the petroleum salesmen in their hour of trouble. One sales manager who was interested in fuel oils once stepped up to a factory chemist and asked him if it were not possible to get out an oil "that was free from carbon" because most of his customers complained that there was too much carbon in these oils. When told that some of these oils had 80 per cent of carbon in them, the excellent man went into a state of coma.

A scientific paper entitled "Oxidation and Reduction" was presented by Ernest T. Little, assistant professor of chemistry at Rutgers College. The author showed by means of carefully planned experiments that oxidation, as well as reduction, is not a molecular, but rather an electrical process. He pointed out that these two processes are influenced by four factors, namely: capacity, intensity, concentration and equilibrium. The capacity factor indicates the possibilities of oxidation for a particular oxidizing agent. The intensity factor is a measure of the strength of an oxidizing agent. It represents the driving force which determines whether or not the possibilities of oxidation are to be fulfilled. The oxidizing potential is determined by experiment and expressed in terms of volts. The concentration factor determines the potential which can be developed. Equilibrium is established when the oxidizing potentials of the reacting substances become equal to each other. In demonstrating these points, Prof. Little used a beaker (A) containing an oxidizing agent in acid solution and beaker (B) containing a salt of the lower state of oxidation (ferrous chloride). Platinum electrodes were inserted in each beaker and the terminals were attached to a delicate galvanometer. Electrical connection was established between the two beakers by means of a U-tube or salt bridge. As the oxygen passed from the permanganate solution to the ferrous chloride solution the galvanometer registered the passage of the current. The positive electricity acquired by the electrode in beaker (A) is carried through the anode to beaker (B) and there it oxidizes the iron to the ferric condition.

Members of the Society who desire to offer papers for the meetings of the Society in the Fall are asked to communicate with Dr. R. P. Calvert (chairman of the committee on program), care of Delta Laboratories, Arlington, N. J. The last meeting before the Summer will be held Monday evening, June 9, in Newark, N. J.

Census of Chemical Imports

THE census of chemical imports for the fiscal year 1913-1914,¹ prepared by the Bureau of Foreign and Domestic Commerce in collaboration with the American Chemical Society, is ready for distribution. It appears several months later than it was promised, but in view of the world conditions in the chemical industry the publication of the census at this time is most opportune. It comprises 2500 items of import valued at \$100 or more, and gives for each the quantity, declared value and country of origin. The last is stated in percentage originating in each country where two or more are concerned. Five-sixths of our imports were crude and one-sixth manufactured materials. The compilation represents the labor of a staff of 24 persons for 10 months, reviewing the records of 110 ports of entry.

The report should be carefully studied. We have endeavored to give an idea of its content by compiling a few tables which are presented herewith. Table I shows the principal countries of origin arranged in order of value of our imports from them.

TABLE I—PRINCIPAL COUNTRIES OF ORIGIN

	Value of Imports	Percentage of Imports		
		Crude	Mfd.	Total
England.....	\$48,235,931	24	20	23
Germany.....	47,507,937	15	41	19
Chile.....	19,734,353	10	..	8
Brazil.....	17,760,918	9	..	7
Belgium.....	17,534,449	8	4	7
France.....	13,102,249	..	30	5
Canada.....	11,840,612	6	..	5

In Table II we list 34 items of chemicals and allied products arranged in order of value of domestic production so that an idea can be gained of the relation of imports and exports to our own production. The groupings are arbitrary, and the fact that we are exceptionally strong in one or weak in another is a matter that can be thoroughly understood only by studying the basic conditions. On the whole, up to 1914 we had not progressed far from our custom of selling our products cheap and buying dear. Compare, for example, the marketing of our phosphate with that of German potash, and the conditions affecting international exchange of material will be seen to be something more than a difference in labor costs. Our wealth in oil products is clearly shown in Table II. Had it not been for this, we probably would have had nothing to trade for German coal-tar products and would have been forced long ago to rely on our ability and ingenuity instead of trading on our natural resources.

IMPORTANCE OF NITROGEN FIXATION

Reference to Item 5, in Table II, shows an \$18,000,000 difference between imports and exports of "chemicals." This difference is almost exactly equal to the value of our imports of Chilean nitrate, which adds emphasis to the economic importance of developing synthetic nitrate processes in the United States. Again referring to Item 5, it is interesting to note that the

¹"Chemicals and Allied Products Used in the United States." By Dr. E. R. Pickrell, Department of Commerce, Misc. Series No. 82. Sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 25 cents, or New York, 734 Custom House; Boston, 1801 Custom House; Chicago, 504 Federal Bldg.; St. Louis, 402 Third National Bank Bldg.; New Orleans, 1020 Hibernia Bank Bldg.; San Francisco, 307 Custom House; Seattle, 848 Henry Bldg.; Cleveland, Chamber of Commerce; Cincinnati, Chamber of Commerce; Cincinnati, General Freight Agent, Southern Ry., 96 Ingalls Bldg.; Los Angeles, Chamber of Commerce; Philadelphia, Chamber of Commerce; Portland, Ore., Chamber of Commerce; Dayton, Dayton Chamber of Commerce.

countries of origin and their respective percentages are as follows: Chile, 37; Germany, 23; England, 13; France, 8; Italy, 5; all others, 14.

In Table III we have selected 50 out of the 2500 items and have arranged them in order of value of imports. It will be noted that 8 of them, namely, sodium nitrate, ammonium sulphate, glycerine, argols, platinum, platinum products, magnesite and sodium cyanide were imported to the value of more than \$1,000,000 each.

Many of the products imported are not commercially important. Thus there are 3000 "orphans" that were imported to a value of less than \$100 each. Many of these, however, are functionally important in certain of our industries and it is quite as essential to the chemical independence of this country that these materials should be produced here as it is that we should avoid dependence on Germany for about \$1,000,000 worth of sodium cyanide. Imported trikresol, for example, was used by our antitoxin manufacturers before the war as a preservative for their products. It took them some time to learn that this simple tar-acid fraction could be made in their own laboratories almost as easily as distilled water and it will be very much to their discredit if they are ever again dependent on foreign sources for this material. In like manner manufacturers must take an equal interest in items that are of small financial but of great economic importance.

In studying this census the reader must remember that it represents conditions in 1914 and that great industrial changes have occurred since then. Our regular 5-yr. census of manufactures covering the year ending June 30, 1919, will indicate the domestic growth

TABLE II—SEQUENCE OF IMPORTS, DOMESTIC PRODUCTION AND

	EXPORTS		
	Imports	Domestic Production	Exports
Oils, mineral.....	\$13,233,057	\$362,573,653	\$124,322,660
Coal-tar products.....	8,818,944	220,238,000	35,359
Oils, vegetable.....	43,467,881	192,365,100	15,913,901
Clays.....	1,985,006	190,688,000	3,923
Chemicals.....	48,278 93	173,269,000	19,859,009
Fertilisers.....	28,038,709	153,196,000	12,111,108
Medicinal preparations.....	1,289,608	150,473,000	6,788,806
Soap.....	788,570	106,994,620	4,941,707
Gums and resins.....	88,903,829	205,282	3,790,874
Paints.....	20,836	70,582,461	1,104,971
Oils, animal.....	1,033,851	51,380,313	851,142
Explosives.....	.....	39,645,382	2,785,633
Varnishes.....	64,066	36,142,256	1,038,864
Salt.....	423,322	34,804,683	550,380
Greases and tallow.....	1,726,971	29,820,000	5,049,814
Pigments.....	2,240,320	27,386,665	3,728,331
Oil cakes.....	117,104	2,191,610	21,667,672
Turpentine and rosin.....	28,818	21,463,890	19,882,165
Dyeing materials.....	995,191	20,620,000	370,676
Cosmetics.....	2,309,827	19,160,407	1,638,841
Baking powder.....	.....	17,870,674	790,274
Inks.....	46,821	16,859,180	625,074
Glues, gelatins.....	2,699,539	13,733,000	306,111
Shoe blacking, polishes.....	41,559	9,882,000	649,395
Abrasives.....	843,881	9,152,000	2,127,945
Waxes.....	1,923,328	8,897,106	6,622,487
Drugs.....	7,672,291	8,080,000	2,798,286
Tanning materials.....	4,228,214	7,123,971	876,257
Candles.....	40,004	3,696,068	283,018
Oils, essential.....	3,552,692	2,565,361	783,629
Asbestos.....	1,678,736	2,814,000	.....
Sulphur.....	424,909	2,676,395	2,018,923
Petrolatum.....	.....	1,243,388	661,889
Bronze powder.....	406,649	.....	.....
Total.....	\$267,480,785	\$2,017,794,065	\$265,019,278

of our chemical industry. When those statistics are available, we can proceed with greater light, but in the meantime the census of imports shows very clearly the extent of our dependence and the direction in which domestic industry must expand.

A careful study of the census may reveal errors or may suggest improvements. Reasonable criticism of any nature is welcomed and should be sent to Chairman of the Import Statistics Committee, American Chemical Society, 35 East 41st St., New York City.

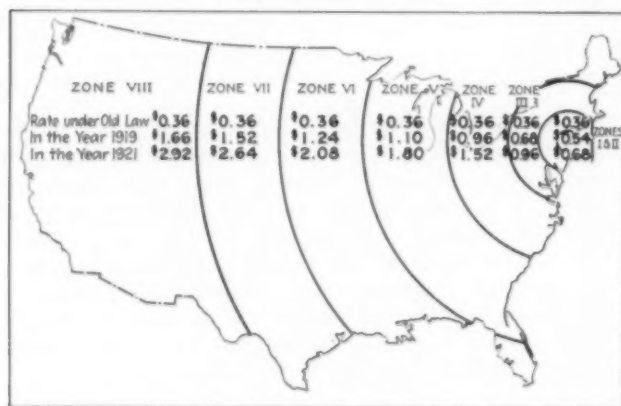
TABLE III—CHEMICAL IMPORTS IN ORDER OF VALUE

	Weight	Value		Weight	Value
Sodium nitrate, long tons.....	564,061	\$17,951,455	Sulphur, long tons.....	19,398	\$355,450
Chile, 99.5 per cent			Japan, 94.9; Italy, 3.8 per cent		
Ammonium sulphate, lb.....	166,753,754	4,888,563	Thorium nitrate, lb.....	147,885	337,700
Scotland, 46.7; England, 22.2; Germany, 19.1; Canada, 7.3; Belgium, 2.6 per cent			Germany, 99.5 per cent		
Glycerine, lb.....	36,409,619	4,486,415	Barium dioxide, lb.....	6,085,909	330,142
France, 30.8; England, 28.7; Belgium, 7.3; Netherlands, 7; Russia, 5.4; Germany, 5.2; Spain, 4.6; Canada, 3.7 per cent			Germany, 45.8; England, 42; Belgium, 12.2 per cent		
Argols, crude, lb.....	29,523,714	3,201,177	Potassium hydroxide, lb.....	8,395,049	320,753
Italy, 46.6; France, 33.6; Portugal, 14.4; French Africa, 3.2 per cent			Germany, 90.5; Austria-Hungary, 4.7; France, 2 per cent		
Platinum, fabricated, oz.....	54,852	2,445,038	Citric acid, lb.....	652,410	304,438
Germany, 53.2; France, 29.7; England, 17.1 per cent			Germany, 57; England, 27.7; Italy, 12.8 per cent		
Platinum, crude, oz.....	40,634	1,489,208	Caffeine, lb.....	95,666	301,078
Germany, 37.2; Colombia, 30.5; England, 17.4; France, 12.1 per cent			Germany, 97.7; England, 2 per cent		
Magnesite, crude calcined, lb.....	289,494,316	1,473,207	Potassium carbonate, crude, lb.....	9,042,754	239,691
Austria-Hungary, 92.8; Netherlands, 2.9; Greece, 2.2; Germany, 1.8 per cent			Germany, 38.1; Russia, 19.7; Belgium, 18.1; France, 16.4; Austria-Hungary, 6.1 per cent		
Sodium cyanide, lb.....	8,523,867	1,243,438	Zinc, dust, lb.....	4,917,667	228,163
Germany, 89.9; France, 7.3; Netherlands, 1.3 per cent			Germany, 74; Austria-Hungary, 20; Canada, 3.3 per cent		
Fusel oil, lb.....	5,802,360	910,759	Tartaric acid, lb.....	906,764	218,915
Russia, 36.2; Germany, 18.2; England, 15.7; Austria-Hungary, 12.7; Belgium, 8.1; Ireland, 2.6 per cent			Germany, 39.5; England, 19.8; Italy, 16.3; Austria-Hungary, 9.1; Netherlands, 8; France, 7.2 per cent		
Casein, lb.....	10,798,614	705,264	Mercury, lb.....	444,896	192,768
France, 57.6; Argentina, 22.3; England, 9.6; Germany, 4.3; Canada, 2.9 per cent			England, 72.5; Austria-Hungary, 11.9; Germany, 10.1; Italy, 5.4 per cent		
Quinine sulphate, lb.....	2,356,621	515,581	Sodium yellow prussiate, lb.....	2,295,921	171,843
Netherlands, 51.9; Danish East Indies, 26.7; Germany, 21.1 per cent			England, 71.9; Netherlands, 11.4; Belgium, 5.9; Switzerland, 4.2; Germany, 3.7 per cent		
Calcium citrate, lb.....	3,097,265	493,738	Palladium, oz.....	3,986	169,171
Italy, 84; British West Indies, 15.6 per cent			England, 83.8; Germany, 12.2; France, 4 per cent		
Ammonium chloride, lb.....	9,076,729	465,429	Cream of tartar, lb.....	827,746	159,972
England, 49.3; Germany, 48.3 per cent			Germany, 100 per cent		
Iodine, lb.....	195,087	433,498	Iridium, oz.....	2,191	155,262
Chile, 100 per cent			England, 37.2; France, 34; Germany, 25.4 per cent		
Oxalic, lb.....	8,595,064	425,008	Ammonium nitrate, lb.....	2,765,960	132,995
Germany, 78.6; England, 10; Norway, 9.1 per cent			Norway, 80.2; Belgium, 17.1; Denmark, 2.6 per cent		
Sodium chloride, lb.....	3,076,071	423,322	Santonin, lb.....	5,239	125,360
England, 34.1; British West Indies, 28.3; Italy, 16 per cent			Germany, 100 per cent		
Bleaching powder, lb.....	47,657,606	420,533	Sodium hydrosulphite, lb.....	505,232	116,197
England, 73.2; Germany, 21.7; France, 4.3 per cent			Germany, 100 per cent		
Yellow K prussiate, lb.....	3,508,225	390,050	Potassium nitrate, crude, lb.....	3,546,580	115,344
Germany, 54; England, 27.6; France, 7.9; Netherlands, 7 per cent			British India, 96.8; Germany, 3.2 per cent		
K ₂ CO ₃ refined, lb.....	10,420,368	368,324	Potassium cyanide, lb.....	808,721	113,199
Germany, 58.5; England, 16.6; Austria-Hungary, 9; France, 6.8; Turkey, 5.4 per cent			Germany, 77.6; England, 22.3 per cent		
			Arsenic trioxide, lb.....	3,034,070	110,168
			Germany, 33.1; Canada, 30.9; England, 23.6; Austria-Hungary, 6.3; Belgium, 6.1 per cent		

Postal Penalty on Western Readers

THE accompanying outline map of the United States has been drawn to show the postal zones for second-class mail matter, and the cost of mailing **CHEMICAL & METALLURGICAL ENGINEERING** to subscribers in different parts of the country. Under the old postal law, national magazines and newspapers were mailable to any part of the country at the uniform rate of 1c. per lb. War-time legislation by Congress repealed this law and instituted a zone system under which the postage on second-class matter increases directly with the distance from the point of publication. The law did not levy the full penalty during the first year, but provided for annual increases in 1919, 1920 and 1921. The publishers of this journal absorbed the increase for the first year, but cannot continue that practice for obvious reasons.

Even a casual study of the figures is enlightening. Under the old law, annual postage on this journal cost 36c., regardless of the destination. A subscriber in



Oregon had equal privileges with one in New Jersey; but this year it will cost \$1.66 to mail this journal to an Oregon subscriber for a year, and only 54c. to one in New Jersey. And that is not the full effect of the law, for in 1921 the respective costs rise to \$2.92 and \$0.68. It must be apparent that these costs cannot be absorbed by the publisher, considering the nominal subscription price charged. They must be passed on to the subscriber, constituting, in effect, an increased subscription price.

Congress should repeal the postal-zone law, and the reading public everywhere can bring about such action by calling the attention of Congressmen to the penalties which are to be imposed on subscribers. By way of compromise, until it can be ascertained whether Congress can be prevailed upon to repeal the law, **CHEMICAL & METALLURGICAL ENGINEERING** will charge extra zone postage of 50c. per annum to those subscribers living west of the Mississippi River. If the law is not repealed, it is evident that we will have to revert to the practice of half a century ago and charge all subscribers a flat price "plus the postage."

Johns Hopkins Scholarships

Through the generosity of the late Mr. William H. Grafflin of Baltimore, a scholarship, to be known as the Grafflin scholarship, and three assistantships have been established in the department of chemistry of the Johns Hopkins University.

The Grafflin scholarship will be awarded annually to a candidate having a training equivalent to that leading to the Ph.D. degree and who therefore has had experi-

ence in research. It may be awarded twice to the same candidate. The holder of the scholarship will receive \$1000 a year and will be expected to devote his entire time to research.

The three research assistantships each pay \$750 a year and are open to chemists having the equivalent of a Ph.D. degree. The holder of a research assistantship will not be required to do any formal teaching, but will be given the opportunity to devote his entire time to research and to assist in the direction of research.

Applications for the year 1919-1920 should be sent to the Department of Chemistry, Johns Hopkins University, 321 Druid Hill Ave., Baltimore, before Aug. 1.

Business Training for Engineers

THE Commissioner of Education has issued a call for a public conference on business training for engineers and engineering training for students of business. This conference, national in scope and in character fully representative of all interests, will be held at the New Willard Hotel in Washington, Monday and Tuesday, June 23 and 24. All educational institutions, commercial organizations, and educational and engineering societies will be invited to co-operate. Engineers, educators and business men will be invited to discuss the following major topics: Business Training for the Engineer; Engineering Training for Commercial Enterprises; Significance of the War Experience for Engineering Education; Training of the Engineer for Overseas Engineering Projects.

The Commissioner of Education has called this conference on behalf of the Conference Committee on Commercial Engineering appointed by him, the chairman of which is Dr. Glen Levin Swiggett, specialist in commercial education of the Bureau of Education, and chairman of the Committee of Fifteen on Educational Preparation for Foreign Service. This committee is composed of administrative professors in engineering and commerce from several of the larger educational institutions and representatives from the Society for the Promotion of Engineering Education, the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Institute of Mechanical Engineers, the American Institute of Mining Engineers, and the Committee of Fifteen on Educational Preparation for Foreign Service.

Chemical Service for Latin America

The Bureau of Foreign and Domestic Commerce, Washington, D. C., is in search of a chemical engineer who has a knowledge of business and markets that will qualify him to make a survey of chemical and allied markets in Latin America. Those who consider themselves qualified to perform this service for the Government are invited to make application to the Bureau on blanks which will be furnished for that purpose. An eligible list will be prepared from these applications and examination will be given for the final selection of a proper agent. The salary will be \$10 per day, with \$4 allowance for subsistence. Transportation expenses will be paid. It is proposed to send the agent to Latin America July 1.

The Boston Meeting of the American Institute of Chemical Engineers will be held June 18-21, with headquarters at the Lenox Hotel. The program for this meeting was published in our last issue.

Kingsport, Tennessee, and Its Chemical Industries—I

A Brief Historical Survey of a Progressive Young American City, With a Technical Description of Its Varied Chemical Plants and Their Processes—Low Power Costs—Large Ceramic and Cement Plants

KINGSFORT is located in the northeast corner of Tennessee, in Sullivan County, on the South Fork of the Holston River, eight miles south of the Virginia line, twenty-six miles west of Bristol and the same distance north of Johnson City. The two latter cities are served by the main line of the Southern Railway, and from Bristol Kingsport may be reached by automobile in an hour and a half, or from Johnson City by an hour's travel on the Carolina, Clinchfield & Ohio Railway.

In 1910 there were on the present site of Kingsport only two farmhouses, and the population of the old town of Kingsport, two miles away from the present site, was 200. On Jan. 1, 1915, there were 900 people in the present town of Kingsport. At the beginning of 1919, four years later, a conservative estimate placed the population of the rapidly growing city at 10,000.

Numerous communities in different parts of the United States have flourished prodigiously during the war, and one might reasonably suspect, at first, that Kingsport's prosperity has been due to war's demands, and that now, with peace in sight, Kingsport will die the death. But if you ask the people at Kingsport, they will tell you that the war has held Kingsport back, and that henceforth, unhampered by the restraints on trade and commerce imposed by war-time restrictions, Kingsport will forge ahead more rapidly than before.

It was in 1915 that it was first foreseen that destiny had decreed that a city of some magnitude would be erected at Kingsport. Foresight was linked with forethought, and in that same year, with a population of less than 1000, it was decided to plan for a city of 50,000, and a professional city planner, Dr. John Nolen, of Cambridge, Mass., was engaged to lay out the design for a city on that basis. Dr. Nolen is still engaged by the city of Kingsport, and the city's growth is being guided by him.

CITY DIVIDED INTO ZONES

Definite sites have been set aside for factories and industrial plants, and ample provision has been made for parks, playgrounds, rest-places, schools and churches, and sensible building restrictions have been adopted, applying to community sections. The city has been definitely divided into zones for manufacturing, wholesale trade, retail trade, and residences, and the benefits of the foresight exercised in this direction have already been felt.

The charter of Kingsport was drafted by the Bureau of Municipal Research of the Rockefeller Foundation. The town government consists of five councilmen, or aldermen, elected by the people at intervals of four years, and the five councilmen elect one of their number to be mayor. As it is possible that any one of the five councilmen might become mayor, a result of this system is that the people exercise more than usual care in their selection of the men who are to constitute the city council. The mayor appoints a city manager, who need not be a resident of the city or State. The latter

appoints and dismisses all other employees of the city. The mayor presides at meetings of the City Council, and is the chief executive officer of the city. He also appoints the school board, two women and three men.

THE SCHOOL SYSTEM

The school system is designed after the system of Gary, Ind., and practical education is a prominent feature. Cooking, sewing, home-nursing, fundamentals of chemistry, bookkeeping, typewriting, shorthand, manual training and agriculture are taught. There is also a play teacher for the little children, and every child is taught vocal music. Around the school-houses there are four acres of playgrounds. There is now one school building, for both graded and high schools, but two new schools have been authorized—both primary schools. In six years the school population has grown from 35 to more than 1000.

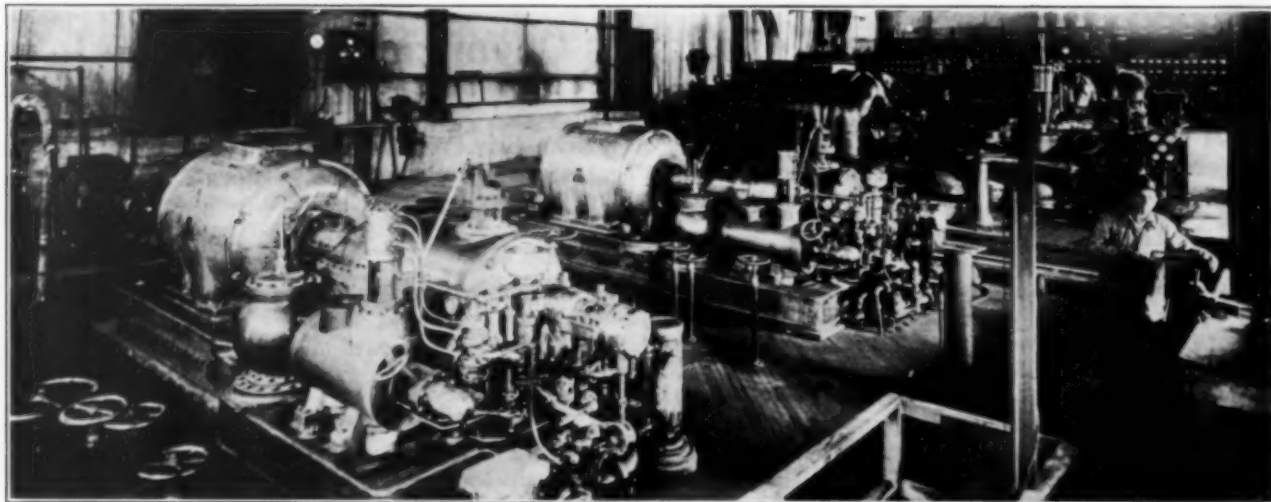
Kingsport has six churches; a modern police department; a volunteer fire department, whose members sleep in a hall with furnished rooms, provided by the city for their use; and a hospital, municipally operated, with accommodations for forty patients. There are four miles of concrete-paved streets of unusual width, built at a cost of \$1.35 per sq.yd. of which the owners of abutting property pay three-fourths, and the paving of other streets with concrete is now under way, all cement, sand and stone being obtained within the city limits. The streets are flanked with wide concrete sidewalks.

A civic center has been provided, centrally located, with ample space reserved for all necessary public buildings. The planting of trees and shrubbery is being done under the direction of a trained landscape engineer, Harlan P. Kelsey, of Salem, Mass.

THE KINGSFORT IMPROVEMENT CORPORATION

A city could hardly have been designed and then built according to design with so much of intelligence and foresight, unless under the direction of some definite authority or power, continuous, at least thus far, in its existence. The sensible development of Kingsport is easily traced to the Kingsport Improvement Corporation, of which Blair & Co., bankers, of New York City, are the owners, with J. Fred Johnson, the chief executive of the corporation at Kingsport, as president. The Improvement Corporation owns the Kingsport Utilities Corporation (a power company to be described later) and much of the real estate in and around Kingsport. The Improvement Corporation is giving special attention to the housing of the population. The company builds houses, and either rents or sells them at cost plus a charge of \$200 or \$300 for the lot, giving terms to the purchaser extending over a period of four or five years. The Improvement Corporation is also interested in developing recreations for the inhabitants, and is now constructing an 18-hole golf course, under the direction of an expert from New York City.

After assigning to the Kingsport Improvement Cor-



POWER HOUSE, KINGSPORT UTILITIES CORPORATION

puration as much of the enterprise, progressiveness and determination as is its due, the fact remains that without some *raison d'être* Kingsport could not continue to thrive. Enthusiasm alone may boom a town for a while, but enthusiasm without substantial merit will not keep it booming. Kingsport has a variety of large industrial plants—a dyestuff and chemical plant, a wood alcohol plant, a cement and lime plant, a tannery and tannic acid factory, a brick plant, a wood pulp mill, a hosiery mill and a gas shell-loading plant. What induced all of these industries to locate in Kingsport within the past few years? And why, now that the war is over, does Kingsport continue to grow—on what do the people base their expectations that now progress will be more rapid than before?

CHEAP POWER AVAILABLE

The outstanding advantage afforded to manufacturers is the opportunity for cheap power. The price of coal delivered at Kingsport for the five years preceding the outbreak of the war was \$1.55 per ton. The ante-bellum price for power generated from this coal was five mills per kilowatt. Another natural advantage is the water of the Holston River. The river being fed by mountain streams, the water is unusually cold, and is useful for condensing purposes. The water is, moreover, remarkably pure—no softening is needed, and the amount of scale found in the boiler tubes is practically *nil*. Again the raw materials for making brick and cement being within the city limits, a brick plant and cement mill are already operating, and timber of many descriptions abounds in the vicinity. Building materials, therefore, are unusually cheap, and these materials are of the very best. The abundance of chestnut, oak and hemlock is responsible for the establishment of a tanning extract plant and a tannery, and the waste wood chips of the extract plant, combined with the ample supply of such woods as poplar, black and sweet gum, and maple were sufficient incentive for constructing a pulp mill. The hardwoods already mentioned, together with the beech and hickory, were the attraction for a wood-alcohol plant. All of these plants co-operate locally with one another, but the cycle of industries is not complete. Some of the resources of the Kingsport district are still undeveloped. Ten miles away there is an extensive deposit of silica, said to be 99.65 per cent pure, which is claimed to be useful for glass making. There are also in

the vicinity valuable deposits of feldspar and kaolin. Other industries that Kingsport is reaching out for are a charcoal iron furnace to utilize the charcoal produced by the wood-alcohol plant; a packing house to foster the native cattle raising industry; a fertilizer plant to utilize the refuse of the tannery and the proposed packing house as well as the potash and phosphate bearing minerals of this section and also to furnish cheap fertilizer for the surrounding agricultural district; a cyanamide or lime-nitrogen plant; and a calcium carbide plant.

KINGSPORT UTILITIES, INC.

Inasmuch as the chief attraction for industrial plants at Kingsport is the cheap power, a description of these plants may properly begin with the Kingsport Utilities, Inc., which furnishes power to all of the local plants, as well as to Gate City Quarry, $7\frac{1}{2}$ miles away, over a 13,200-v. line. The corporation also lights the city of Kingsport.

Kingsport Utilities, Inc., was established in 1910. The capitalization is \$500,000 common stock, \$500,000 preferred, and \$500,000 bonds. The original capacity was 3500 kw., which was increased in 1916 to 11,500 kw. The boiler equipment consists of four 600-hp. Edgemoor boilers, 250-lb. pressure, four 300-hp. Babcock & Wilcox boilers, and four 300-hp. Heine boilers, equipped with boiler feed pumps, feed water heaters, coal and ash handling machinery, etc.

ELECTRICAL EQUIPMENT

The electrical equipment comprises two 4000-kw. Allis-Chalmers turbo generators, 6600-v., 3-phase, 60-cycle; one 2000-kw. turbo-generator of the same make and voltage; and two 750-kw. Allis-Chalmers turbo generators, 440 v., stepped up to 6600 v. through transformers. The entire plant runs in parallel. Power is sold at "cost-plus basis." The cost of power to the various industrial plants is to-day about 1c. per kilowatt. About 4000 kw. of the total capacity is at present not utilized, but extensions now in progress at some of the industrial plants will soon absorb this surplus power. The corporation is prepared to enlarge its plant to any capacity that may be needed.

At the present time the cost of coal at the mine is \$2.36 per ton, and freight to Kingsport is 58 cents. This coal comes from the Clinchfield district of Virginia. The following table gives complete information regard-

ing the analysis and fuel value of the principal coals of this region:

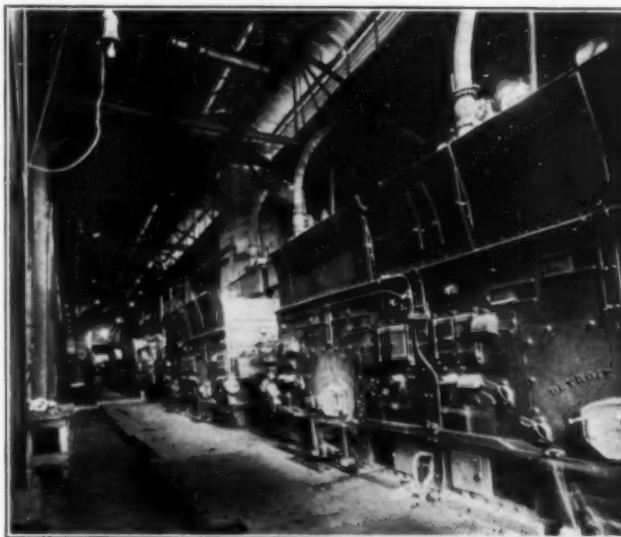
ANALYSIS OF CLINCHFIELD COALS			
Proximate Analysis			
Coal Seam	Upper Banner	Lower Banner	No. 4 Seam
Moisture 105 deg. C.....	0.95%	1.00%	0.50%
Dry volatile matter.....	36.95%	35.30%	32.70%
fixed carbon.....	55.95%	57.80%	60.80%
Coal ash.....	7.10%	6.90%	6.50%
	100.00%	100.00%	100.00%
B.t.u. det'd.....	14,560	14,660	14,580
Ultimate Analysis			
Hydrogen.....	5.25%	5.60%	5.10%
Carbon.....	80.10%	80.00%	79.80%
Nitrogen.....	1.55%	1.50%	1.60%
Oxygen.....	5.40%	5.20%	6.40%
Sulphur.....	0.60%	0.80%	0.60%
Ash.....	7.10%	6.90%	6.50%
	100.00%	100.00%	100.00%
B.t.u. calculated.....	14,510	14,740	14,580
By-Products			
Coke, lb. per ton.....	1,568	1,613	1,658
Gas, cubic feet per ton.....	10,000	10,000	10,000
B.t.u. per cu.ft.....	600	600	600
Tar, gal. per ton.....	12-14	10-12	8-10
Ammonium sulphate, lb. per ton.....	22	20	20

The normal coal consumption of this power plant is 225-250 tons per day. The water used in the boilers comes from the South Fork of the Holston River, which flows within 100 yd. of the plant. This water is so free from scale-forming impurities that when the boilers are cleaned every ninety days, a scale of $\frac{3}{16}$ in. in thickness is all that is found.

THE WATER SUPPLY SYSTEM

Kingsport Utilities, Inc., also owns the water supply system for the city of Kingsport. An impounding reservoir of forty acres, holding about 275,000,000 gal., is fed by various mountain streams. This reservoir is located $7\frac{1}{2}$ miles from Kingsport, with an elevation above the city of 590 ft. There are two reducing valves on the pipe line to the city, to reduce the pressure to 135 lb. There are 20 miles of water main (10 in. to 4 in.) in the city.

This water is piped to all of the industrial plants for fire protection and for drinking purposes. A filtering plant is now being installed, with a capacity of 1,000,000 gal. per day, and provision for an increase to 4,000,000 gallons.



BOILER HOUSE, KINGSPORT UTILITIES CORPORATION

KINGSPORT BRICK CORPORATION

The Kingsport Brick Corporation, established in 1910, was the first industrial organization to locate in Kingsport. The products of this plant are sewer pipe in all sizes from 4 in. to 24 in.; common red shale brick, face brick, "rugs," "newstiles," "textiles," radial chimney blocks, hollow building blocks, and chemical brick. The capacity of the entire plant is 150,000 bricks a day.

The plant is built near an unlimited supply of shale, the analysis of which is similar to that of the shale used by the Clinchfield Portland Cement Co., which is quoted farther on. The shale or clay is mined by steam shovel within 1000 ft. of the works, and is loaded on cars which are drawn by wire rope on a narrow gage track into the mill building. The clay is unloaded from the cars to a conveyor belt by which it is conveyed to a 9-ft. "dry pan," where the clay is ground to about 16 mesh. It is then passed through a 16-mesh screen, called a "piano wire screen," the wires running in one direction only, and the screened clay to be used for making sewer tile goes to the "wet pan," while that for making bricks goes to a pug mill. The process of making sewer tile will be described first.

In the wet pan the clay is mixed with a suitable quantity of water, and is then elevated to a belt 3 ft.



KINGSPORT BRICK CORPORATION

wide, called the slow feeder. This dumps the clay into a hopper called the fast feeder, which is handled intermittently to charge the sewer pipe press. When the slow feeder has delivered to the fast feeder a sufficient quantity of clay, an operative quickly shoves the fast feeder over, and delivers the charge of clay to the press. The sewer pipe press, manufactured by the American Clay Machinery Co., Bucyrus, Ohio, has various capacities, according to the size of the pipe being manufactured, as follows:

Capacity, in Number Lengths	Diameter of Sewer Pipe, In.	Length of Sewer Pipe, Ft.
5000	6	2.0
4000	8	2.5
3500	10	2.5
3000	12	2.5
2500	14	2.5
2000	15	2.5
1800	16	2.5
1500	18	2.5
1200	20	2.5
1000	24	2.5

In the sewer pipe press the clay is shaped into the desired size and length, and the lengths are then dried at 100 to 200 deg. F. for from four days to a week. Odd shapes of sewer pipe, such as short elbows, reducers, etc., are molded in plaster of paris molds. Sewer pipe and drain tile are burned in the kilns for five days. For $3\frac{1}{2}$ days the temperature is brought up gradually, finally reaching about 2000 deg. C., and that temperature is continued for a day and a half. Salt is then added in the proportion of 150 lb. to a kiln, and firing is stopped. In some cases salt must be added twice. After 30 min. of "soaking," the kiln may be cautiously opened. It is then allowed to cool down gradually, about five or six days being allowed for the cooling process.

For the manufacture of brick, the ground and screened clay is elevated by bucket elevator, and then is discharged into a hopper which feeds a pug mill. Here the necessary amount of water is added to give the batch the right consistency, and the damp clay then passes to the brick machine (also manufactured by the American Clay Machine Co., Bucyrus, Ohio), where the mass is molded into a long, rectangular, horizontal column, which passes on to a wire brick cutter, made by E. M. Freese & Co., Galleon, Ohio.

By means of the wires on this cutting machine the clay column is cut into individual bricks.

The bricks are dried at 300 to 400 deg. F. by loading them on push cars which are very slowly passed through a coal-fired drier. The time required for drying is 30 hr. After drying, the bricks are fired in the kilns for six days. The temperature in the kiln is brought up gradually until the atmosphere in the kiln clears. It is then assumed that the kiln has acquired a substantially uniform temperature throughout and the temperature is increased to about 1900 deg. F. No pyrometers are used in the kilns, as it is found that on account of slight variations in the clay mixtures the temperature can be better controlled by means of test pieces, or small samples of

bricks. The heat is held at about 1900 deg. for 24 hr., and the kiln is then allowed to cool gradually. For chemical brick, after the usual firing is finished, everything is shut up tight, and the heat is allowed to "soak" into the brick for four hours. The ordinary building bricks manufactured by this company are said to show an absorption of only 2 per cent by weight, after immersion in water for 24 hours.

There are 29 kilns in all, each 30 ft. in inside diameter, with the walls lined with 9 in. of fire brick and a fire brick roof. The usual life of a kiln is 20 years. The capacity of one kiln is 84,000 bricks. The consumption of coal for firing is 600 to 700 lb. per thousand bricks. The company markets its products all the way from Lexington, Ky., to Jacksonville, Fla., the present selling price being \$18 to \$22 per thousand, according to quality.

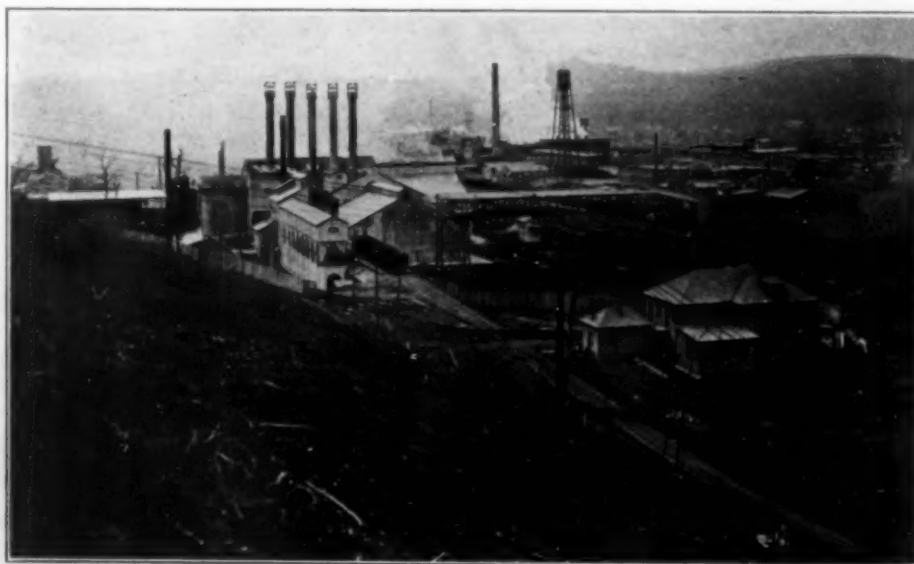
CLINCHFIELD PORTLAND CEMENT CORPORATION

The raw materials used by the cement company at Kingsport are: Limestone, obtained from Gate City, Va., about eight miles distant; shale, quarried within a few hundred yards of the cement mill; and sand, obtained from the Watauga River. The following table gives typical analyses of these raw materials, as well as of the finished cement.

TYPICAL ANALYSES

	Gate City Limestone	Shale	Sand	Cement
SiO ₂	1.18	58.76	81.20	22.10
Al ₂ O ₃	0.33	22.39	10.10	6.98
Fe ₂ O ₃	0.77	7.91	3.98	3.10
CaCO ₃	96.46	2.84	.....	.....
MgCO ₃	1.95	1.43	.....	.....
CaO.....	.....	.....	0.89	62.62
MgO.....	.....	.....	.....	1.66
SO ₂.....	.....	.....	.....	1.84
Loss.....	.....	.....	.....	1.93

The limestone is brought from the quarries in hopper-bottom cars and is dumped over a tippie into a storage pile. From this pile it is drawn on to a conveyor belt operating in an underground tunnel, and is elevated by a bucket elevator to two Hammar mills, manufactured by the Pennsylvania Mills Co., Philadelphia, Pa. Here it is crushed to $\frac{1}{8}$ -in. size, and then the crushed limestone is carried back to the blending bins, each of which is provided with an automatic sampler that delivers a sample representative of the bin, as it is filled. The samples are analyzed for calcium carbonate. The blend-



CLINCHFIELD PORTLAND CEMENT CORPORATION

ing bins are in charge of the laboratory, and no limestone can be used until such use is authorized by that department. After the analysis of a sample is completed, the laboratory releases for use the blending bin corresponding to such sample, and adjusts the scale for weighing the shale, in proportion to the percentage of calcium carbonate found in the limestone. The scales used are the Richardson Automatic Scale, made by the Richardson Scale Co., New York.

The shale is quarried by hand, and rolled into the mill by hand, the cars delivering the shale to a pair of crushing rolls, from which the crushed material is carried by belt conveyor to the shale storage bins. From these it is tapped into a belt conveyor and delivered to a rotary drier, fired with coal, 5 ft. in diameter by 40 ft. long. The dried shale then goes by bucket elevator to a bin over the scales.

After the necessary adjustment of the scales, the limestone and shale are weighed, and then the two are mixed, both scales tripping at the same time, discharging the materials into a screw conveyor under the scales. This discharges the mixture of materials to a bucket elevator, which hoists it to a point over the driers. Here the material divides into two directions, and falls into two rotary steel mixture driers, 6 ft. in diameter by 60 ft. long, fired by pulverized coal, which is blown from the kiln room into the mixture driers by a blast of air, through a 4-in. pipe 160 ft. long.

The dried mixture falls into a pan conveyor and goes to the raw grinding department. Here it is carried by bucket elevator to bins above five Hammar mills, two manufactured by the Pennsylvania Mills Co., Philadelphia, and three by the Williams Patent Crusher Pulverizer Co., St. Louis, Mo. In these mills the mixture is reduced to proper fineness for the tube mills, i.e., 80 per cent must pass through a 20-mesh screen. The crushed mixture is elevated by bucket elevator and delivered to a rotary screen, and any oversize is returned to the Hammar mills. The fines pass on to the tube mill bins. The seven tube mills pulverize the screened mixture so that 97 per cent will pass through a 100-mesh screen, and deliver the product to a screw conveyor, which discharges to a bucket elevator, and this to another screw conveyor, overhead, which delivers the dried and pulverized raw mixtures to the kiln boxes, or, if desired, to a silo or storage bin for holding a reserve supply of pulverized mixture sufficient for one day's run.

CEMENT KILNS

The cement kilns are made of steel plate, lined with fire brick, 9 in. thick at the firing end, tapering to 4 in. at the rear end. There are five of these kilns, each 8 ft. in diameter by 125 ft. long. The pitch of the kilns is $\frac{1}{4}$ in. per ft. The speed or rotation varies from $\frac{1}{2}$ of a revolution to 1 revolution per minute. The speed is regulated by variable speed motors, operated at the firing end. The kilns are fired with pulverized coal, whose fineness is such that 96 per cent will pass through a 100-mesh screen.

The coal pulverizing equipment consists of four mills, manufactured by the Raymond Bros. Impact Pulverizer Co., Chicago, and two Ruggles-Coles driers. Each kiln is equipped with an independent blower unit, manufactured by the American Blower Co., Detroit, Mich. The amount of coal fed to the kilns is regulated by cone pulleys. From the kiln box the pulverized mixture drops into a screw conveyor, and then into a second screw conveyor below the first, for regulating the speed

of delivery to the kiln. The material is fed into the kiln dry. The temperature in the kiln is about 2500 deg. F.

The clinker falls into pits beneath the kilns, is hoisted by bucket elevator and delivered to rotary coolers. There are two of these, one taking the output of two kilns and the other the output of three kilns. The coolers are old bottle-shaped kilns, 60 ft. long, varying in diameter from 4 to 7 ft. In each cooler there are four angle irons, which help to tumble the clinker about inside the revolving cooler.

From the coolers the clinker is discharged to a bucket elevator, and thence conveyed by pan conveyor to the clinker storage pile, which is exposed to the weather. This has two underground tunnels beneath it, provided with belt conveyors. The clinker is tapped through holes, at any desired point in the storage pile, and is carried back to the finishing mill.

Here there are two rotary driers, in which the clinker is dried, elevated, and dropped into a scale, which weighs 20 bbl. at a time. At the scale, $3\frac{1}{2}$ per cent of crushed gypsum is introduced. The scale dumps into a pit, from which the dried clinker is elevated by bucket elevator to an overhead pan conveyor, delivering to the Griffin mill boxes.

There are ten Giant Griffin mills (40 in.) made by the Bradley Pulverizer Co., Allentown, Pa. In these the dried clinker is ground so that 100 per cent will go through a 20-mesh screen. The ground material then goes through four Allis-Chalmers tube mills, where it is pulverized to standard specifications, which are, usually, that 80 per cent must pass through a 200-mesh screen. The pulverized cement is elevated to a screw conveyor, which carries it to 24 bins, 12 in each of two stock houses, the capacity of each bin being 4000 bbl. In the stock houses the cement is drawn from the bins into screw conveyors running transversely, and delivering into a central conveyor which feeds the six Bates automatic packing machines, manufactured by the Western Valve Bag Co. of Chicago. After packing in bags, the cement is trucked to cars for shipment. The capacity of the plant, running 24 hr. per day, 12 hr. per shift, is 2500 bbl. of cement daily.

COTTRELL PRECIPITATOR

The Clinchfield Portland Cement Corporation has just completed the installation of a complete Cottrell precipitating plant, comprising both a dry treater and a wet treater, for precipitating the dust from the cement kilns, with the twofold object of recovering potash and eliminating a nuisance. A steel flue 9 ft. wide by 14 ft. deep, provided with hopper bottoms and screw conveyor beneath, conveys the gases from the kiln to the dry treater. This flue, and also the stacks which permit the gases to escape into the atmosphere, are provided with dampers, so that the gases may either be allowed to escape or be diverted to the treater at will. A small quantity of dust low in potash may be precipitated in the flue. The flue is 102 ft. long, and on the top of it, to utilize some of the waste heat, there are evaporating pans 9 ft. by 9 ft. by 6 in. deep in the center, for evaporating the solution returned from the wet treater. By means of the screw conveyor underneath the flue, the dust can be returned to the kiln, in case the price of potash should not warrant putting the dust on the market. The portion of the flue nearest the dry treater is provided with a water spray inside, to humidify the gas.

The dry treater, built of steel and brick, consists of four chambers, two on either side of a central combination inlet and outlet flue. This flue in its entirety is rectangular in shape, with a diagonal steel partition extending from the bottom of the inlet end to the top of the outlet end. The top part, above the partition, is the inlet flue, and the bottom part, below the partition, is the outlet flue. The ports for letting the gas into and out of the four treating chambers are provided with dampers. In each chamber the gases pass down through eighty 12-in. iron pipes, each 15 ft. long. In the center of each pipe, from top to bottom, hangs a soft annealed iron wire, No. 14, B. & S. gage, with an iron weight, shaped like the frustum of a cone, weighing about 9 lb., suspended at the bottom. To keep the wires from swinging, and to keep them spaced properly, the wires pass through an iron grid, placed 15 in. below the bottom



COTTRELL PRECIPITATOR AT CEMENT PLANT

of the 12-in. pipes and just above the 9-lb. weights. This grid is made of flat iron strips, 1 in. wide by $\frac{1}{8}$ in. thick. The grid is stiffened at two diagonally opposite corners, by omitting the usual wire from the 12-in. pipes at these corners, passing through each of these two pipes, instead of the wire, a $1\frac{1}{2}$ -in. iron pipe which is firmly fastened at the top, and also to the grid at the bottom.

The current is transmitted by means of a $\frac{3}{8}$ -in. iron pipe connecting with a bus bar made of 5-in. iron pipe. This connects to the various iron wires suspended in the 12-in. pipes. The bus bars are insulated by means of Alberene stone slabs, made at Schuyler, Va. The insulators consist of eleven slabs, six of which are 6 in. by 6 in. by 1 in. thick, and the five others 9 in. by 9 in. by 1 in. thick.

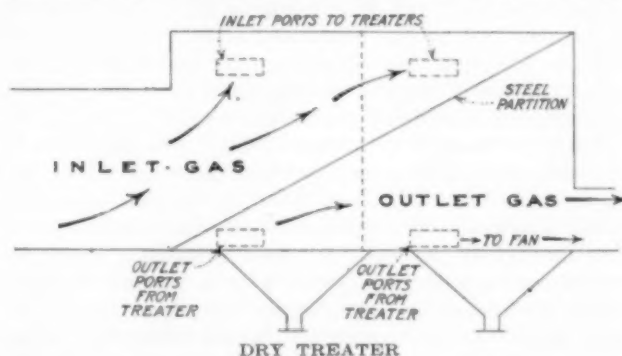
The four treaters discharge the gases into a common outlet flue, which leads to a Buffalo Forge Co. conoidal multiblade fan, with impeller 12 ft. in diameter and speed of 144 r.p.m., and said to be capable of discharging 180,000 cu.ft. of gas per minute.

The dry treater will precipitate only the coarser dust. The very fine dust and the fume will be blown by the fan to the wet treater. The temperature of the gas in the dry treater ranges from 900 to 1100 deg. F. The capacity is 20 tons of dust per day, which is expected to contain about 10 per cent of water-soluble potash (K_2O). The treater will operate continuously, but the dust will be withdrawn from the hopper-bottoms only at intervals, and will be packed for shipment without further treatment. This equipment has already been tested experimentally, and undoubtedly by this time it is in continuous operation.

The wet treater, like the dry treater, has four cham-

bers, but here the chambers are arranged in a single row, with the inlet flue passing along one end of the four chambers. The gas is blown into this flue by the large fan mentioned above, and is admitted to the treater chamber through dampers of the "jug" type, two dampers being provided for each chamber. The gas passes upwardly through the damper openings (about 36 in. in diameter) then turns at right angles to the left and passes into the chamber, which is provided with six vertical concrete partition walls, each 6 in. thick by 10 ft. wide by 14 ft. high, built 15 in. apart. These walls divide the chamber into seven compartments, and in each compartment there are suspended, between the walls, 24 iron wires, No. 14 gage, weighted at the bottom with 30-lb. weights, and connected to one another at the bottom by a grid made of $1\frac{1}{2}$ -in. iron pipe. There are 168 of these wires in all in each chamber. The surfaces of all the walls are covered with flowing water, which is distributed at the top by means of a system of pipes. The gases, after turning to the left, pass through the seven compartments, the fine dust and fume are precipitated by the high tension current with which the 168 wires are charged against the wet walls, and are washed by the flowing water to the bottom, and the gas passes on to the left end of the compartments, and escapes through a damper hole to an outlet flue which connects with all four of the chambers, and leads to a concrete exit stack, 8 ft. in diameter by 18 ft. high.

Power for the treaters is obtained from the Kingsport Utilities Corporation at 440 v., and by means of four motor generators it is changed to 220 v., a.c. single



phase, and is then stepped up by transformer to 75,000 v.

The precipitated liquid and dust are collected in a tunnel beneath the treater chambers, and flow to a concrete settling tank 24 ft. in diameter by 12 ft. deep at the deepest part, the bottom being funnel-shaped. The liquid is pumped to the evaporating pans previously described, on top of the gas flue, and is there evaporated. The sludge from the settling tank is filter-pressed, and the cake rejected. The filtrate returns to the settling tank, and is pumped along with the other liquid to the evaporating pans on the flue. The evaporation is not carried to dryness, but at a definite specific gravity the liquid is drawn off into two final evaporating pans 16 ft. long by 8 ft. wide by 3 in. deep, fired with coal, where the evaporation is completed and solid crude potash obtained. The Cottrell plant, as well as the cement mill, was designed and built by Richard K. Meade & Co., Baltimore, Md.

The Clinchfield Portland Cement Corporation also owns and operates a lime-burning plant, located a short distance from the cement mill. It consists of five vertical kilns, built by Richard K. Meade & Co.

Flotation for the Practical Mill Man

A Description of Several Important Factors in Concentration by Flotation — Extraction and Grade of Concentrate — Slime Effects — Pure Water — Time — Oils — Pulp Density — Recleaning Concentrates

BY FREDERICK G. MOSES

IT IS a well known fact that the difficulties encountered in flotation plants in different sections of the country are many and varied. While it is true that, in the great majority of mills, the troubles are soon located and remedied, there are many other plants which are not so fortunate in the solution of their problems. It is usually found in the latter case that, although there is nothing apparently wrong with the mill or its operation, the results being obtained are not so good as the experimental work on the ore had led the builders to believe could be obtained. Because a profit is being made, the idea of leaving well enough alone often leads the operators into the state of mind in which they are satisfied to make the best of a bad situation and to be content with the results that they can get.

There are some cases in which the mill results are not satisfactory and, moreover, cannot be readily improved. This is, however, seldom the case. More often the poor results are caused by some condition, often a simple one, that can easily be remedied, if located. Unfortunately, there is such a multiplicity of conditions, any one of which can cause poor flotation results, that it is hopeless for the average mill operator to investigate more than a comparatively few possibilities.

It will be the object of this discussion to suggest some of the factors affecting flotation results, and to suggest ways in which some of them may be overcome. Of course, it will be possible to consider only a limited number of the conditions that work for poor flotation results. There is always the chance, however, that a discussion of some of the more common difficulties encountered in flotation plants will suggest the manner by which some specific or unusual source of trouble can be discovered and eliminated.

FLOTATION A CONCENTRATION PROCESS

It is imperative that the fact that flotation is a concentration process, as much as any gravity scheme, be borne in mind. If this fact is remembered when considering any phase of flotation, the solution of the problems connected with its operation will be considerably simplified.

As flotation is a concentration process, it must follow that the economic laws of concentration will apply to it as much as to the gravity concentrator. In every case of concentration there is a maximum extraction and grade of concentrate possible. This theoretical result can be approached in the commercial installation, but never reached. Usually the greatest obstructions in the way of obtaining scientific results are the economical considerations that surround the mill operator on all sides. The plant must be run to make the greatest profits, and attempts to obtain better metallurgical results will often serve only to reduce the profits.

It must also be borne in mind that, like a table, the capacity of a flotation machine is limited. Notwith-

standing the fact that the maximum capacity is but seldom reached, there is always the possibility that this be done, to the detriment of the results obtained on the machines. If the operator takes care that the apparatus is not overloaded, he has eliminated many of the chances for poor work in his plant.

The crushing of flotation feed is as important to good flotation results as the crushing of table feed is important to good table work. The sizes that can be floated are limited to a fewer number than can be tabled successfully, and poor sizing or classification of flotation feed can cause even more unsatisfactory results than in gravity machines. The ore must, of necessity, be crushed fine enough to free the maximum quantity of mineral, but with the production of the minimum amount of slime or very fine material. The slimes, especially the true colloidal material, will be found to be more often the cause of poor flotation than any other factor that will be encountered in the plant.

EXTRACTION AND GRADE OF CONCENTRATE

The metallurgical and economical success of the flotation plant depends on the recovery of the greatest amount of the valuable mineral from the ore in the purest possible concentrate. Just what are the economical limits of extraction and grade of concentrates depends on local conditions and must be determined for each mill; in the present discussion, they will be considered to be the best metallurgical results allowable under the conditions existing in the locality of the mill.

As already suggested, each ore has a maximum and definite ratio of concentration, and hence there is a maximum grade of concentrate possible. The maximum extraction is, of course, 100 per cent of the values in the ore, a figure that can only be approached. The important fact to be remembered in this connection is that in the flotation plant, as in the gravity mill, recovery can be increased only at the expense of grade of concentrate, and vice versa. The flotation operators who remember this fact will save themselves much trouble and worry that always follow attempts made to obtain scientifically impossible results. Unfortunately, so few plants are approaching theoretical results that their consideration can be eliminated from the present discussion.

FLOTATION RECOVERIES

Ignoring, for the present, the consideration of grade of concentrate, it can be said that extraction by flotation depends on many factors, among the most important of which are: (1) The physical condition of the ore being treated, (2) the flow sheet of the mill, and (3) the effectiveness of the flotation operation. While the first two are not so important as the last, they are so often the cause of flotation difficulties that they should be considered.

At the present time, the mineral values that occur in

the ore as sulphides are all that can be depended upon to be recovered by flotation. When only non-oxidized sulphides are present, it should be possible, theoretically, to obtain high metallic extractions. However, when such easily oxidized material as iron sulphide is present and carries values, as often happens, trouble in obtaining good recoveries may be encountered. There have been put on record cases in which this material, by simply lying in the ore bins for a short time, has undergone enough oxidation to make the flotation of the iron sulphides very difficult. The remedy, of course, for a condition of this sort is to mill the material as soon as possible after it has been hoisted.

The size of the sulphide particles occurring in the ore greatly affects the possible recovery from an ore. When this sulphide reaches the flotation machines in very coarse sizes it will not float. Unfortunately, on the other hand, when the sulphide particles have been ground too fine, or "slimed," they can be floated only with difficulty. In most cases it will be found that the greatest loss in the tailings from a flotation plant is in the minus 200-mesh material. Proper crushing previous to flotation will correct these conditions to a great extent. However, the actual size and condition of the sulphide, as it occurs in the ore, will be a very dominant factor.

All ores carrying decomposed or kaolinized minerals are difficult to float. This physical condition will probably have more effect on the actual flotation operation and its results than any other single thing that could be mentioned, and at the same time it is the most difficult to overcome. Why clay and other colloidal material have such harmful effects is difficult, at best, to explain on a scientific basis. A discussion of this point will delve so deeply into the pure theory of flotation as to be out of place in this consideration. Instead, a few suggestions about means of eliminating or controlling this material will be more to the point.

There may be said to be two general schemes by which the detrimental effect of slime may be overcome. The first and most important is by flocculation or precipitation by chemical or electrochemical schemes. The second and least used method is that of washing. Heating of the ore before crushing is sometimes tried.

Rather than give a long scientific definition of just what colloidal material is, it will be better to give a very simple method of determining the presence and amount of this material. Colloidal material, or more commonly "slime," can be best detected and its quantity estimated by the slowness with which it will settle in water. A rough application of this scheme can be made by taking a portion of the flotation pulp and shaking it thoroughly in a bottle. If there is any quantity of colloids or slime present the water will remain murky after standing for a few minutes. If this cloudy appearance persists for half an hour there is probably sufficient slime present in the pulp to interfere with flotation.

The amount of the slime that may be present may be roughly estimated by the depth of clear water that appears on top of the pulp in a given time. Of course, this means will only give comparative results, but this is all that would be required except in special cases.

REMOVAL OF SLIME

Some simple chemical compounds, under certain definite but usually little understood conditions, have the property of causing the suspended or deflocculated slime

in the pulp to collect together, or flocculate, changing the physical conditions in such a way that rapid settling occurs. It has been found by experiment that slime in this condition usually has very much less harmful effects on flotation than when deflocculated. Sulphuric acid, lime sodium carbonate, acid sodium sulphate, copper sulphate and many other substances, when used in very small amounts, have the property, under certain conditions, of flocculating the slimes. In this way their harmful effects are very largely removed.

At the present stage of our knowledge of this phase of flotation, it is practically impossible to foretell which of the numerous reagents that have been used for this purpose will give the required results on a particular ore. The most effective one can only be determined by experiment under the conditions under which it is to be used. The reason for this is our lack of knowledge of the real manner in which they act on the slimes in the ore.

The ideal manner of ascertaining the reagent to be used is by direct experimentation in the commercial cells of the operating plant. If, for any reason, this is not feasible, indicative results can sometimes be obtained by a series of tests made in bottles. Several samples of the pulp from the flotation machines, containing the oils being used, are placed in a series of bottles and well shaken. Two or three drops from solutions of the various reagents are then added to the bottles, a separate bottle being used for testing any one solution. The bottles are then placed where they will be free from vibration for an hour or more. It will be seen, at the end of this period, that some of the bottles have a certain volume of clear water above the cloudy pulp and that, in certain cases, this volume will vary widely. It is usually the case that the reagent showing the greatest settling effect will produce the best results when used in the cells. However, this is not always the case.

The removal of slimes or colloids by washing is a more difficult matter, requiring quite an installation of settling tanks or thickeners, and a comparatively large supply of fresh, pure water. This last item is of the utmost importance. The actual operation of the scheme is quite simple. The pulp, before being floated, is settled in the thickening tanks, which are so operated as to give the thickest spigot product possible, without allowing the overflow to carry away an excessive amount of valuable mineral. The overflow, which carries a large portion of the slime material, is allowed to run to waste, and the thick spigot product is diluted with sufficient clean, fresh water to give the correct pulp density for flotation. This method has worked well in several large plants in the West.

Another scheme which might be used, but which for various practical and economical drawbacks has received but scant attention, involves heating the ore before crushing to a temperature great enough to put the slime-forming material in the ore into such a physical condition that slime formation is retarded when the ore is wetted and crushed.

There are many materials foreign to the ore, such as decomposed vegetable matter, lubricating oils from line shafts or crusher bearings, soap, sewage, grease from mine-car wheels, etc., that will interfere greatly with flotation. The only sensible remedy for this type of trouble is to eliminate the source of it. Great care must be taken to prevent these substances from getting into the flotation feed. The great difficulty often encountered

in finding the source of this sort of interference makes it imperative that care be used to eliminate it.

MILL FLOWSHEETS AND THEIR EFFECTS

Sometimes it does not seem possible that such a simple matter as the location of a table in a flotation mill could make any great difference in the results obtained. Nevertheless this has often been proved to be the case.

It is as necessary that the flowsheet of a plant using flotation be as carefully worked out by experiment as when gravity processes only are to be used. Many flotation plants can be shown to be doing unsatisfactory work for this reason alone.

In many instances, the ore should be tabled previous to flotation in order to remove the heavy sulphides which are present but which cannot be floated. These will only tend to build up in the machines, choking up the cells and preventing their efficient operation. Also, it is sometimes possible so to remove from the pulp certain deleterious substances, such as slimes.

In certain cases the best results demand that the pulp be tabled after flotation. A great tendency in many flotation plants is to carry too dilute pulp in the flotation apparatus. Tabling before flotation is bound to add water to the flotation feed and this causes poor operation. Tabling following flotation has not this drawback.

The use of pilots by which the work of the flotation machines can be judged should not be overlooked in this connection. The flotation operators can soon be taught from the appearance of the tables treating the flotation tailings whether the cells are doing good, bad or indifferent work. They thus have an optical demonstration of what their part of the general scheme is accomplishing, and this will always work toward securing better results from the flotation machines.

Before leaving the discussion of mill flowsheets and their bearing on flotation results, the effects of various types of crushing on flotation results should be mentioned. This is one of the things that is without the pale of help from the operator, but some valuable suggestions may be evidenced by the consideration.

There is no doubt that the type of crushing to which the ore has been subjected before flotation will have a noticeable effect on the results obtained. The well-known case of the Inspiration mill, where a better result was obtained by crushing with iron on iron than by pebbles on iron, is an example of what a difference such a simple point can make.

The fact that the type of crushing which produces a large amount of slime is not as satisfactory as that which will produce the minimum quantity has been already suggested. A certain plant in Arizona is divided into two units, exactly alike, except for different types of crushing machines employed in them. The ore, flotation equipment and other factors are the same. The extractions obtained in the two units always varied to a certain extent, and the difference in the crushing was the only explanation that could be offered as the reason for this peculiar behavior.

Flotation has a definite field in saving that portion of the sulphide content of an ore that is too fine for satisfactory gravity work. It can never be made to replace tables satisfactorily, except under an unusual combination of circumstances. Stage crushing, therefore, with the removal of the mineral as soon as it is freed,

followed by flotation of the sulphides that have been crushed too finely for table work, in general seems to be the best and most logical scheme, and should be followed whenever possible.

EFFECTIVENESS OF FLOTATION OPERATION

The points already discussed have been mentioned because of their indirect effect on flotation. There are, also, certain factors in the operation of the flotation equipment itself that are of even more importance to good flotation results than those already mentioned.

One of the most important factors in good flotation is the oils or combination of oils that are being used. If all of the other conditions are perfect with the exception of the oil, good flotation results are impossible. Unfortunately, the investigation of oils covers such a large field and depends on so many little understood or unknown factors, that no definite rules for determining the most satisfactory oil can be given.

As long as the art of flotation has been practiced, the only feasible method of determining the oil best adapted for an ore has been by laboratory or mill experiments. This method of investigation involves much time, patience and money, but the importance of the information gained always justifies the expenditure. The operator should never reach the state of mind that permits him to be satisfied with the oil he is employing. He should test all of the logical mixtures available, and as new oils come on the market, they should, also, be given their chance.

The agitation to which the oil and pulp have been subjected is the next important factor in good flotation results. This must be correct, both with regard to kind and amount. The lack of sufficient agitation is usually evident at once, but too much is more difficult to recognize and is just as harmful as the opposite state of affairs.

Too much agitation will do one of two things: either produce too much froth, usually of an unsatisfactory character, or cause the oils to be so thoroughly emulsified as to destroy much of their flotation value. It is very probable that the principal function of much of the acid used in flotation is to throw oils out of emulsion that have received too much agitation in the ore pulp.

If the mechanical agitator type of machine is not designed correctly for the ore which it is to treat, it will either produce too much froth or too little. Either of these conditions will tend to cause poor recovery. When the ratio of the size of the agitator and its speed is correct, or that of the agitator compartment to the froth tank or spitzkasten, the quantity of froth produced by the use of the right amount of oil will be wrong. In such a case, the common method of attempting to rectify conditions is by changing the amount of oil used. This is unsatisfactory in most cases.

If too little froth is being made by the machine by the use of the correct amount of oil, air blown into the pulp at the bottom of the spitzkasten will often correct matters very satisfactorily.

The troubles caused by the production of too much froth when the correct amount of oil is being used are much more difficult to rectify. The greatest chance for improvement, under these conditions, is to increase the tonnage to the machine, although other factors may cause this scheme to fail.

Over-oiling the flotation pulp will usually be indicated by the occurrence of large amounts of mineral-bearing

froth in the launders carrying the tailings from the machines, or on the tables or other apparatus that may be used to re-treat the flotation tailings.

IMPORTANCE OF PURE WATER

One of the greatest necessities for good flotation work is a large and constant supply of fresh and pure water. It is considered good flotation practice to settle the water from the flotation tailings for re-use in the flotation circuit, in order to obtain the benefit of the oils that will be returned to the mill in this manner. This is logical and works very well, within certain limits. A point that must at the same time be considered is that the soluble constituents of the ore or oils will gradually be concentrated in this return water, and will eventually attain an accumulation that will interfere very materially with the operation of the flotation machines. For this reason, increasing the amount of fresh water that is being added to the flotation circuit will often work wonders in the way of improving flotation results. This fact is very easily determined and the test should be made at frequent and regular intervals.

Often the fresh water supply of the mill will carry certain unsuspected impurities in solution. These impurities may be either harmful or beneficial. The preponderance of chances are, however, that they will interfere with the proper operation of the cells. Fortunately, most of the inorganic salts that occur in this way can be very easily and cheaply removed by simple chemical precipitation. Many cases have been known where the flotation plant had been built on the strength of a large amount of successful experimental work, but no successful results could be obtained until by chemical analysis of the water used in the mill circuits the presence of large amounts of inorganic salts in solution had been demonstrated. When this material had been removed by the use of lime or some other necessary reagent the mill at once commenced to produce the results that had been expected when the plant was completed.

Organic material, such as soaps, glues, decomposed vegetable matter, organic soil constituents, etc., will cause more harm in the flotation plant than the inorganic salts just mentioned. Their removal is a much more difficult proposition. If their presence can be proved to be the cause of trouble, it would be better to employ special talent to handle the situation rather than to allow inexperienced men to try their hand.

TIME FACTOR AND FLOTATION RESULTS

The period of time during which the ore pulp is under treatment in a flotation machine is a most important factor of good flotation results. Flotation is by no means an instantaneous process. A certain definite time is required to remove the concentrate from the ore pulp. The amount of time required for this purpose depends on several important considerations, among which may be mentioned (1) the amount of pulp, in gallons, which is being treated in the flotation apparatus per minute, (2) the solid content of the pulp volume being treated, (3) the number of pounds of concentrate that must be removed from each gallon of the pulp, (4) the strength or carrying power of the froth being made on the machine, and (5) the quantity of froth being made per unit time.

It will be evident that, other things being equal, the

more dilute the pulp the greater will be the velocity with which each unit of ore in the pulp will pass through the machine. Hence, to obtain the same time of treatment on the more dilute pulp will require a greater comparative length of time of treatment in the machine. When dealing with pulp dilution, however, many other factors enter into consideration and the above can only be taken as a generality.

On the other hand, a pulp must not be too dense, or the bubbles cannot rise freely to the surface. When the pulp is too dense there is the added chance that the bubbles will be scoured clean of their mineral load. The correct pulp density to fit the conditions of the case can only be determined definitely under practical operating conditions.

A froth has a certain maximum carrying power. When it is made at a definite rate per minute it can lift only a certain limited amount of concentrate. If more pounds of concentrate are contained in the pulp fed to the machine than can be removed by this froth, poor extraction of the sulphide in the ore is bound to result. When the poor recovery in the flotation machines can be definitely laid to this condition, the remedy is either to feed a smaller volume of pulp to the apparatus, to make more froth of the same character or, by means of different oils, to increase the carrying power of the froth being produced. The most satisfactory method of remedying the difficulty must depend on the ore and the other local conditions existing in the plant. These points are all matters of experiment and skill of operation.

RELATION OF GRADE OF CONCENTRATE TO EXTRACTION

In all ore-dressing and concentration processes, the grade of concentrate produced has a most important relation to the possible extraction. A few of the more important reasons why this is especially true in flotation will be mentioned.

An observation of the froth forming on the top of the pulp in a flotation machine will clearly show that a great deal of the concentration that takes place in the machines takes place in the froth. The froth nearest to the pulp will be practically the color of the pulp, but the closer the top the froth is observed, the more nearly its color approaches that of the pure mineral that is being floated.

This effect is caused by a mechanical action that goes on within the body of the froth itself. The bubbles seem to have only a comparatively weak selective action on the sulphides in the pulp itself. This condition causes the froth, first released at the bottom of the froth column, to carry a very large amount of gangue material. As soon as the froth is out of the water, however, it commences to break up, the bubbles first formed breaking up to re-form a slightly fewer number of new bubbles. During this process of re-formation, the sulphides are caught on the newer bubbles formed, while the gangue is, to a large extent, forced to drop back into the pulp owing to the decreased froth surface. This action goes on from the bottom to the top of the froth column, causing the froth the greatest distance from the pulp itself to be the highest in grade.

It can be seen from this that the deeper the froth column carried on top of the pulp in the flotation machine, the higher is the grade of concentrates produced and the greater is the amount of gangue dropped from the froth into the pulp, at the same time, however, the greater is the chance for the sulphide particles to be

dropped into the pulp and lost in the tailings, causing a lowered extraction.

This shows the reason for the relation between the grade of concentrate produced and the extraction possible, and, also, the principal reason for the use of one set of machines for producing the best tailing possible, and the use of another set of apparatus for recleaning the froth produced on the first machines.

PRODUCING CLEAN CONCENTRATES

At the first of this discussion, the fact was mentioned that, in order for a plant to be successful from both a metallurgic and an economic standpoint, a good extraction of the values in the ore must be obtained, and a high grade concentrate must be produced.

The concentrate is the material that must be sold to produce the income from the milling operation. The greater the amount of valuable metal present, the more can be obtained for it, while the smaller the amount of impurities present, the fewer the penalties imposed by the buyer and the less charged for their treatment. All these considerations make it imperative to produce the highest grade concentrate economically possible.

The grade of flotation concentrates produced will depend on several factors, among which can be mentioned (1) the natural amenability of the ore to the process, (2) the simplicity of the sulphide content of the ore being treated, (3) the sort of results that the flotation equipment is being operated to obtain, and (4) the skill and care with which cleaning the concentrates is done.

The first two of these factors are, to a great extent, beyond the control of the operators. However, the second two are of such a nature that they can be much influenced and controlled by the operators.

NATURAL AMENABILITY OF ORE TO FLOTATION

It has been often found that two ores, apparently of the same physical and chemical makeup, respond very differently to flotation, the one giving maximum results without trouble, while the other can only be treated satisfactorily with the greatest difficulty. Just why this is true is often very difficult to explain.

It is, however, usually easy to obtain both high grade concentrates and high extractions when treating the ores that respond easily to flotation, the probable reason being that when dealing with this type of ores, a small amount of the lighter oils will give high recoveries of the sulphides present, and, at the same time, this type of oiling will in nearly all cases produce the richest concentrates.

When dealing with the other ores—those which can only be made to respond to flotation treatment with difficulty—it is usually necessary, in order to obtain high recoveries of the sulphides, to use a comparatively large amount of heavy flotation oils. This class of oils will, it is true, make high recoveries, but in so doing often float such large amounts of gangue as always to cause the concentrate to be low grade.

As suggested, these factors usually depend more on the ore itself than on any of the conditions that can be controlled. However, from the above it can be seen that when the ore is readily amenable to flotation, both high recoveries and rich concentrates can be produced by the same operation, but when the ore does not respond readily, high recoveries can be obtained with greater ease than high grade concentrates, and neither can be gotten at the same time.

In an ore composed of simple gangue minerals and only one floatable mineral, it is easy to see that the chance of producing high grade concentrate is greater than when two or more minerals that float are present.

COMPLEXITY OF SULPHIDES AND GRADE

When several sulphides, such as lead, zinc and iron sulphide, for instance, are present in the ore, there are two possible schemes that might be used in overcoming the tendency for the production of, say, a low grade zinc concentrate. The success of either of these will depend largely on the character of the ore and its sulphide constituents. One of these methods involves the removal of one or more of the sulphides by gravity before the flotation of the ore for the recovery of the other sulphide. The other scheme depends on a differential or selective flotation operation to recover one of the sulphides without removing the other two. This has been done to a limited extent in various sections of the country, but at best it is a very delicate operation and will require large amounts of experimental work, careful control of the flotation operations themselves, knowledge of the relations of the various minerals to one another and, above all, great skill in the actual operation of the equipment.

There is no question that the grade of the flotation concentrates can be influenced greatly by some such schemes as those mentioned, but their success is bound to be limited. They are really special cases of flotation and should not be discussed here.

FLOTATION OPERATION AND GRADE OF CONCENTRATES

Probably the greatest factor affecting the grade of the product is the manner in which the machines themselves are run from shift to shift. The grade of the concentrates will depend largely on (1) whether the machines are being operated to obtain the maximum recovery or the maximum grade of product, (2) on the skill and intelligence with which the oils are used, (3) on the skill and care with which the pulp level and depth of froth on the machines are controlled, and (4) on the pulp density.

The effect of the first point mentioned, the results that are being striven for on the machines, has been suggested already. Much of the concentration takes place in the froth column, and when the froth is allowed to discharge from the apparatus so slowly that most of the gangue has had time to drop from it, some of the mineral will also be dropped into the cells, causing a lowering in the recovery, but at the same time the maximum grade of product will result. Just the point at which these two conditions should be balanced is an economic matter and can only be worked out on the profit sheet of the mill.

The fact should be emphasized at this point that beyond a certain point the grade of concentrate can only be better at the expense of recovery, and vice versa. This will be the dominating thought that will be carried through any discussion involving extractions and grade of concentrates by flotation processes, or any other process, for that matter.

OIL AND GRADE OF CONCENTRATES

The necessity for the intelligent use of flotation oils and reagents to obtain the highest grade of product from a flotation machine has also been suggested in another connection, and should be fairly evident. The strength and carrying power of the froth will depend

largely on the kind and amount of oil used in the circuit. The grade of the concentrate also depends very largely on the same factors. If a weak froth can be made which will carry sufficient sulphide to give a high recovery, this froth, from its very nature, will not be prone to carry much of the gangue.

If a froth of a strong, stiff character is required to give high extractions, it will tend to carry much more gangue material and hence produce a lower grade of concentrate. As the oils are the dominating factor on which the strength and carrying power of the froth depend, the evident relation of the oils to the mineral purity of the concentrate should be clear.

Of course, the ideal practical condition will be to use the oil mixture that will prevent the flotation of the gangue to the greatest extent, and yet float all of the sulphides present in the machine. Under this condition the highest recovery will be possible, and the concentrate produced will be ideal for cleaning in the cleaner cells.

PULP LEVEL OR DEPTH OF FROTH

The relation of the level of the pulp and the depth of froth to the grade of the concentrates was suggested in connection with the remarks on extraction. Slowly discharging froth and deep pulp level mean a long period of time for the concentration in the froth column to take place, with the dropping out of a correspondingly large amount of impurities from the froth.

The operators can soon learn, under the different conditions that will be encountered, the correct depth of pulp to obtain the highest extraction and, at the same time, the maximum grade of concentrates. The pulp level will depend to a certain extent also on the quality of sulphides in the pulp fed to the machine.

As a general rule, the larger the amount of sulphide that must be removed from the machine, the higher the pulp level will be carried, and the faster the froth will be discharged. The operators soon learn to judge these conditions, and make the necessary adjustments when they are required.

PULP DENSITY AND GRADE OF CONCENTRATES

The reasons for the variations in the pulp density upon the grade of concentrates are a little more difficult to understand. The ratio water to solid in a flotation machine has much to do with the character of the froth the machine is producing. Just why this should be true is hard to say.

It has been previously shown that the character of the froth affects the grade of concentrate. Now froth characteristics will continue to have the same effect on the purity of the concentrate, regardless of whether they can be traced to under- or over-oiling of the pulp, or by thickening or diluting it, as in the case now under discussion.

There is yet another manner in which the pulp density may affect the purity of the concentrate. It is the effect of the pulp density on the amount of sulphide that will be carried into the machine in a certain time.

A flotation machine can produce a given amount of froth of certain characteristics in a given period of time. If a dilute pulp is being fed to the machine, there will be fewer pounds of sulphide to be removed by this amount of froth; a condition that, due to its unsaturated condition, will increase the chances of the froth picking up the gangue material, and therefore lowering the purity of the concentrates.

As would be expected, increasing the pulp density will tend to have the opposite effect on the grade of concentrates. In this case, there is an increase in the amount of mineral to be floated by the available froth, causing it to become quickly saturated with sulphide and so leaving but little space for the gangue material. This result is probably brought about by the fact that the sulphides are the easiest to float and will have the greatest tendency to be attracted to the froth and held there, in preference to the non-sulphide material. This condition in the machine will also tend to increase the concentrate grade, but at the same time lower the extraction.

RECLEANING FLOTATION CONCENTRATES

The practice of re-floating concentrates produced on rougher cells as a means of increasing their purity is nearly universal at the present time. A short consideration of some of the factors influencing the results obtained by this practice will be of interest.

Successful recleaning of the flotation concentrates in cleaner machines involves several factors: (1) The general idea of all concentration that the grade of the product from a concentrating machine will be higher the richer the feed to the apparatus, (2) the fact that gangue material in flotation concentrate can be eliminated by re-forming the froth under more quiet conditions than those under which it was first produced, (3) making the amount of froth smaller in proportion to the amount of mineral to be lifted, tending to give concentrates of the highest possible grade.

If these facts are true, and they are generally assumed to be so, we can say that the effectiveness of the recleaning or re-floatation operation will depend on the following: (1) The ratio between the capacity of the cleaner cells and the amount of the concentrate to be re-floated, (2) the purity of the first concentrate produced for recleaning, (3) the skill used in the operation of the recleaning machines, (4) the extraction obtained in the cleaner machines, and (5) the water dilution of the froth being re-treated.

Before proceeding to discuss these points, one fact should be emphasized that is usually assumed to be true but is seldom mentioned: Nearly all minerals have the property of adhering to flotation froth but, of course, in widely differing degrees. An extreme illustration would be the case of limestone and galena. They have both been made to float, and their commercial separation by means of flotation depends only on the degree with which one floats in preference to the other under given conditions.

On this assumption, it follows that when several minerals are present, the most readily floatable will be the first attracted to and carried by the froth, and when the froth has picked up all of the mineral possible and there is still remaining space available this space will then be filled by the next most easily floatable mineral in the pulp, and so on.

With these facts in mind, it should be quite simple to see the importance of having the cleaner cells of a correct size to produce the correct amount of froth to take care of the mineral that is coming to them in the rougher concentrate. As already mentioned, the amount of froth produced on a flotation machine in a given time is a definite and limited quantity. The amount of froth produced, therefore, should be just sufficient to carry the amount of pure mineral that will come to it

from the rougher cells and no more. As the quantity of froth produced will depend on the size of the froth discharge area, other things being equal, the necessity of having the correctly proportioned cleaners should be clear. Practice has shown the above to be true. Several illustrations could be shown where the grade of the final concentrate has been very materially improved by simply decreasing the number of cleaners that were being used.

It follows that the number of cleaner machines in a mill does not depend on the number of rougher machines in the plant but on the number of pounds of concentrate that each rougher produces in a given time.

The effect of grade of feed and its relation to the purity of the cleaner concentrate should be easily seen, especially in view of what has just been said. The higher the grade of the feed to the cleaners, the less are the impurities that are to be eliminated from it, and the less is the work the cleaners will be called upon to do. Usually the grade of the concentrate that is produced for recleaning is determined by the extraction to be made on the roughers, which in turn is determined by economic conditions. This factor is, therefore, to a large extent outside of the control of the operator, except in the more limited sense.

The skill of the operator will probably be shown to a greater extent in the operation of the cleaner cells than in any other manner. He must be taught to run the machines so that just the correct amount of froth will be made and discharged to carry out of the machines the pure mineral that is coming to it, and no more. This can only be done by thoroughly understanding what the machines are expected to do, and closely observing their action from day to day.

It should not be necessary to emphasize the fact that cleaner cells must make the highest extraction possible, consistent with making the necessary grade of concentrate. An excessive loss at this stage of the process only means an excessive quantity of mineral to be returned to the roughers in cleaner tailings, salting the circuit and placing an added load on the roughers, with the increased chance that some of the mineral will be lost in the final tailings, giving an excessively low extraction for the complete operation.

At the same time, it has been shown that grade of concentrate can only be increased by a certain loss in extraction. It is, of course, necessary that the cleaners be so operated that a sufficiently high grade of concentrate is produced. A comparatively poor extraction will therefore be made in the cleaners. Economic considerations will govern this phase of the operation of the cleaner cells. It is common practice, and also logical under many conditions, to operate the cleaners to produce the highest grade of concentrate possible to be made when producing at the same time cleaner tailings equal in valuable mineral to the original rougher feed. This is not always possible, however, and must be governed by other conditions to a great extent.

The last point in the operation of the cleaners is the dilution of the concentrate being cleaned on them. This again brings us to the consideration of the relation of the quantity of froth and the amount of mineral to be saved. The quantity of mineral going to the cleaners should be so regulated that the amount of mineral going to the machine is just sufficient to load the froth. The point that should be watched is to have the pulp dense enough so the mineral actually in the feed will

do this. When this is not the condition, it can often be remedied by making less froth on the cleaners or by using less oil on the roughers, causing them to make a froth containing less water. Another remedy would be to reduce the number of cleaners. The desired extraction usually limits the use of these remedies.

When the pulp in the cleaners is too thick and water is needed, only fresh, pure water should be used; under no conditions should return water carrying flotation oil be employed. Return water will carry enough oil to increase the cleaner froth and aggravate the conditions it is used to rectify. The cleaner, to produce concentrate of the maximum purity, should be rather under-than over-oiled.

CONCLUSIONS

Several possible sources of unsatisfactory results in the flotation plant have been suggested with possible means for remedying them. In many cases, however, it will be found that the employment of these suggestions will not improve results as had been expected. In most cases, this will not be surprising. When the innumerable factors that can influence flotation results are remembered, it is little wonder that the varying of one or even two of them will make no evident improvement in results. It is only by long contact with the problem, and the understanding of all the various factors and their inter-relations, that the hoped for results are obtained.

Many operators, in striving for perfect metallurgical results, lose sight of the economic side of the situation. Unfortunately, very often, especially in flotation, the correction of or the improvement in one step of the process will only be to the detriment of some other step. This fact must always be borne in mind. When in doubt as to whether the apparent benefits derived from the improvement of some point in the operation are really justifiable, the profit sheet, the true standard of success of all technical operations, should be appealed to for guidance.

Salt Lake City.

Detecting Overheated Bearings

Certain double iodides of mercury with other metals are dimorphic and exhibit a more or less pronounced color change at the transition point. H. T. Pinnock¹ has made a study of these in order to determine which compounds are most suitable for use as visible indicators of overheating in bearings and machinery.

The double iodide of silver and mercury, AgI.HgI_2 , is a pale lemon yellow powder at ordinary temperatures, but changes to a vivid carmine at 90 to 100 deg. C., the change in both directions being fairly sharp. With copper mercuric iodide, $\text{CuI}_2.2\text{HgI}_2$, the change from a vivid scarlet vermillion to a chocolate brown takes place at 60 to 70 deg. C. It was found that a mixture of the two, consisting of 85 per cent of the copper salt and 15 per cent of the silver salt, was more sensitive and gave an exceedingly sharp transition from vermillion to almost black at 60 to 70 deg. C.

For application to bearings, etc., these compounds are mixed with white shellac spirit varnish or, for more elevated temperatures, a medium such as is used in aluminum paints for steam pipes, in the proportion of 100 g. compound to 70 cc. of medium. This paint is best applied as a bullseye or band on a zinc white background. After the paint is dry, it should be protected with a coat of colorless oilproof varnish.

¹J. Soc. Chem. Ind., Mar. 15, 1919, p. 78R.

The Art of Searching Chemical Literature

BY HAROLD HIBBERT

THERE is no more important phase of research or technical work in chemistry than that indicated by the above title. Thus, whether the chemist is concerned with the acquirement of a comprehensive knowledge of the properties of any particular compound for research or technical purposes, or again with matters relating to patent and other litigation, the ability to search the literature rapidly, thoroughly and efficiently is of prime importance, and no less important is the saving of time and money in preventing the "new" discoveries of old facts.

In the first place, in order that the chemist may be thoroughly equipped to carry out an investigation of the chemical literature, it is necessary that he should be able to read both French and German readily, and if he possesses a nodding acquaintance with Russian and Italian so much the better.

It is difficult not to be impatient with the foolishness shown in the outcry against the teaching of German in the public schools and colleges, since no matter what our present feelings may be with regard to the German nation, the fact remains that a very large proportion of our chemical knowledge and scientific facts are only to be found to-day in German periodicals, special treatises and text-books, so that it is imperative on the part of the future chemist to acquire a good thorough knowledge of this language.

In this article the question of conducting a search of the chemical literature will be dealt with more from the point of view of the technical chemist than from that of the university student. At certain schools of chemistry such as the Universities of Illinois and Pittsburgh, it is understood that special courses of from six to eight lectures are given on this subject, and in connection therewith, actual practical work carried out relating to literature research and abstracting.

It would be an admirable thing if this scheme could be extended to all of our leading colleges and the full lecture course published in book form for the benefit of chemists in general.

The method of conducting a search of chemical literature will vary depending on whether the product to be investigated is of organic, biochemical, inorganic or mineral origin, and the question of the method to be adopted in the case of organic derivatives will be first discussed.

THE SEARCH OF ORGANIC CHEMICAL LITERATURE

With regard to this field, if it is only desired to ascertain from the analysis of a certain new product whether its properties correspond to those of some substance already known, the matter is much simpler than where we are concerned with the desire to ascertain whether the product in question has been either (a) made previously by any method, or (b) made previously by a specified method, or (c) where we desire information regarding the chemical behavior of the compound.

Scheme 1. If the chemist is merely concerned with the properties and identification, it is sufficient for him to determine first of all its empirical composition and then by reference to Richter's *Lexikon der Kohlenstoffverbindungen* 1910-1912 or better, the *Stelzner Literatur-Register der Organischen Chemie* 1910-11, in case

the derivative is to be found in the latter, to obtain the corresponding reference to the product in *Beilstein's Organische Chemie*, from which, by perusing both the original and supplementary volumes, the desired information can in general be obtained. If the physical properties such as specific gravity, refractive index, melting-point, boiling-point, etc., are not given, they can very frequently be obtained by referring to the journals in which the various researches on the subject are published.

In many cases, as regards the physical and chemical properties of the derivatives, much time may frequently be saved by referring in the first instance to well known reference books such as:

- (a) 1. Kaye and Laby—*Tables of Physical and Chemical Constants* (1918).
2. Liddell—*Metallurgists' and Chemists' Handbook* (1916).
3. Chemical Rubber Co.—*Handbook of Chemistry and Physics* (1919).
4. Van Nostrand's *Chemical Annual*.
5. Landolt-Bornstein *Phys. Chem. Tabellen*.
6. Mullikin—*Identification of Organic Compounds* (1911-1916).
7. Rosenthaler—*Der Nachweis organischer Verbindungen* (1914).
8. Biedermann—*Chemiker Kalendar* (1916).
9. Seidell—*Solubilities of Inorganic and Organic Substances* (1911).
10. Comey—*Dictionary of Chemical Solubilities* (1896). (New edition in the press.)
11. Tables—*Annuelles* (1912-1914).
12. Fowle—*Smithsonian Physical Tables*.

Scheme 2. On the other hand, the chemist may wish to ascertain the best method for making a specified organic derivative. In this case he should first follow the method outlined under *Scheme 1*, and then from the references given consult the original literature.

In addition to this, he should review the decennial indexes (author and subject) of

- (b) 1. *Chemical Abstracts* (Amer. Chem. Soc., 1907 —).
2. *Chemisches Centralblatt* (1830 —).
3. *Berichte der deutschen chemischen Gesellschaft* (1868 —).

as well as the following text-books and encyclopædias:

- (c) 1. Meyer-Jacobson—*Lehrbuch der organischen Chemie* (1907).
2. Richter—*Chemie der Kohlenstoffverbindungen* (1894).
3. Bender-Erdmann—*Chemische Präparatenkunde* (1893-1894).
4. Schmidt—*Ausführliches Lehrbuch der pharmazeutischen Chemie* (1910).
- (d) 1. Ullmann—*Enzyklopädie der technischen Chemie* (2 vols.), 1914-1915.
2. Molinari—*Treatise on general and industrial organic chemistry* (2 vols., trans. Pope, 1912-1913).
3. Vanino—*Handbuch der präparativen Chemie* (1914).
4. Thorpe—*Dictionary of Chemistry* (5 vols., 1912-1913).
5. Watts—*Dictionary of Chemistry* (4 vols., 1911-1914).
6. Ure—*Dictionary of Arts, Manufactures and Mines* (4 vols., 1867-1878).
7. Dammer—*Chemische Technologie der Neuzeit* (3 vols., 1910-1911).
8. Blücher—*Auskunftsbuch für die chemische Industrie* (8th Ed., 1913).
9. Sadtler—*Industrial Organic Chemistry* (4th Ed., 1912).
- (e) 1. Weyl—*Die Methoden der organischen Chemie* (2 vols., 1911).
2. Lassar-Cohn—*Arbeitsmethoden* (4th Ed., 1907).

If the chemist desires to manufacture a product by some scientific process involving purity of material

rather than a consideration of yield, the methods referred to in the literature under (b) will probably best answer his purpose.

On the other hand if he wishes to ascertain the best method for producing a product commercially, that is, under conditions where the yield is probably more important than scientific purity, more detailed information is likely to be found in the literature quoted under (d) and (e).

The two volumes quoted under (e) are very valuable from the point of view of giving the research and technical chemist important information as to the various devices and schemes incidental to oxidation, reduction, hydrogenation, chlorination, etc., which have been found useful in overcoming the experimental difficulties relating to the synthesis of a wide variety of organic derivatives. Very frequently by referring to the index for the particular derivative in question (or failing this, the next lowest or related member of the series) the desired information can at once be obtained.

In this connection it is felt that where important processes are published in scientific journals, difficult for the average man to read or translate, the American Chemical Society should give even fuller abstracts so that it would be possible to repeat the work without having to consult the original. These remarks are made with special reference to the valuable scientific data published by the Russian Chemical Society.

Scheme 3. It frequently happens that the chemist is called upon to make a thorough search of the literature either for the purpose of obtaining a complete knowledge of the subject or for patent or other purposes of litigation, and in this case a more careful and elaborate study is necessary.

In the first place much of the earliest information, modes of preparation, and properties of organic derivatives are not to be found in Beilstein, so that at the outset a thorough search should be made through volumes such as:

- (f) 1. Erlenmeyer—Handwörterbuch der Chemie.
2. Fehling—Handwörterbuch der Chemie (8 vols., 1871-1913).
3. Kolbe—Ausführliches Lehr- und Handbuch der organischen Chemie (3 vols., 1880).
4. Muspratt—Chemistry as Applied to Arts and Manufactures (2 vols., 1860).
5. Muspratt—Theoretische praktische u. analytische Chemie (10 vols., 1886 —).

Having gone carefully through these treatises, he is then ready to study the original and supplementary volumes of Beilstein, as a result of which the literature relating to the particular derivative in question, as well as to its closely related analogues, should have been carefully abstracted.

The latter procedure is of importance, since it often happens that valuable information, while not disclosed in the literature relating to a given product, is frequently quoted in a description of a closely related derivative. Thus a process for reducing nitroxyline might not be found, let us say, under xylydine, but might be found by studying the preparation and properties of the corresponding toluidine.

In general the next procedure would be to go carefully through the yearly indexes of list (b), which, though somewhat laborious, enables a thorough search to be made. If as a result of this review a still more thorough and complete one is deemed necessary, the following journals should then be carefully abstracted:

- (g) 1. Dingler—Polytechnisches Journal (1820 —).
2. Wagner-Fischer—Jahresbericht (1855 —).
3. Kopp-Fittica—Jahresbericht über die Fortschritte der Chemie (1847 —).
4. Biedermann—Technisches Chemisches Jahrbuch.
- (h) 1. Meyer—Jahrbuch der Chemie (1891 —).
2. Chemisches Centralblatt (1830 —).
3. Journal of American Chemical Society, Abstracts (1907 to date).
4. Journal of Chemical Society, London, Transactions and Abstracts (1849 —).
5. Comptes Rendus (1835 —).
6. Bulletin de la société chimique (1861 —).
7. Liebig—Annalen der Chemie (1832 —).
8. Berichte der deutschen chemischen Gesellschaft (1868 —).
9. Journal für praktische Chemie (1828 —).
10. Monatshefte für Chemie (1880 —).
11. Annales de chimie et de physique (1792 —).

Those listed under (g) are particularly valuable as reference works to the older literature, especially in patent cases and chemical litigation, while those given under (h) contain a fuller account of recent investigations. Advantage should always be taken of the fact that in many cases the decennial indexes may be consulted, thus saving considerable time. Furthermore, information is often obtained in a somewhat roundabout fashion, as for instance with regard to certain acetyl derivatives, by reviewing the properties of acetyl chloride or acetic anhydride on the one hand, and those of the amino or hydroxy derivative on the other.

The chemist will naturally be guided by such questions as the nationality and location of the men who have worked in this particular field as to the probable source of references covering the particular subject, so that very frequently much time may be saved by consulting such journals immediately without going through the whole of those specified above.

If the subject relates to dyestuffs or their intermediates, search should be made through the following journals and text-books:

- (j) 1. Friedländer—Fortschritte der Theerfarbenfabrikation (1877 —).
2. Zeitschrift für Farben- und Textil-Chemie (1902 —).
3. Bulletin de la Société industrielle de Mulhouse (1831 —).
4. Bulletin de la Société d'encouragement pour l'industrie nationale.
5. Knecht, Rawson and Lowenthal—Manual of Dyeing.
6. Bucherer—Lehrbuch der Farbenchemie (1914).

If the search relates to a patented process, then a review should be carried out of

7. Winther—Patente.
8. Friedländer—Fortschritte der Theerfarbenfabrikation (1877 —).

In general, it may be said that when it is necessary to make a thorough investigation of the patent literature, it is, as a rule, advisable to confide this to some well known patent attorney, not only versed in patent law, but also possessing more than a passing acquaintance with chemistry, since the methods employed for locating foreign and other patent references call for specialized training.

The classified compendia issued by the British Patent Office will be found very useful in connection with research and especially patent investigations. As the British office data are classified according to subject they provide a valuable aid in reviewing the patent situation relating to any specific product.

It frequently happens that the chemist is called upon to ascertain whether some process has been tried out

previously on a technical, as distinct from a scientific scale, and in this case he should consult special monographs, and text-books on the subject, extending the search to all monographs, university theses, government and other special treatises dealing with the subject.

Certain technical journals dealing especially with applied chemistry should also be reviewed, for example:

- (k) 1. Journal of Industrial and Engineering Chemistry (1909 —).
2. Chemical and Metallurgical Engineering (1902 —).
[Electrochemical Industry, I-II, 1902-1904; Electrochemical & Metallurgical Industry, III-VII, 1905-1909; Iron & Steel Mag. combined with last named, IV, 1906; Metallurgical & Chemical Engineering, VIII-XVIII, 1910-1918; Chemical & Metallurgical Engineering, XIX —, 1918 —.]
3. Journal of the Society of Chemical Industry (1882 —).
4. Zeitschrift für angewandte Chemie (1887 —).
5. Revue générale de Chemie pure et appliquée (1899 —).
6. Chemiker Zeitung (1877 —).
7. Die Chemische Industrie (1878 —).
8. Revue de chimie industrielle (1890 —).

When the search relates to a specific subject such as explosives, rubber, pharmacology, gas, water, hygiene, etc., the special journals and text-books relating to them should be reviewed.

SEARCH OF LITERATURE ON BIOCHEMISTRY

In view of the marked developments in the domain of biochemistry, it becomes of increasing importance for the organic chemist to keep in touch with this work. One of the best text-books on the relation between physiological action and constitution is Fränkel's *Die Arzneimittel-Synthese*.

For special methods reference should be made to:

- Oppenheimer—*Die Fermente und ihre Wirkungen* (4th Ed., 2 vols., 1913).
Oppenheimer—*Handbuch der Biochemie* (4 vols. and suppl., 1908-1913).
Abderhalden—*Handbuch der biochemischen Arbeitsmethoden* (8 vols., 1910-1915).
Abderhalden—*Lehrbuch der physiologischen Chemie* (2 vols., 1914-1915).
Abderhalden—*Physiologisches Praktikum* (1912).
Hoppe-Seyler—*Handbuch der physiologisch-und-pathologisch-chemischen Analyse* (5th Ed., 1883).

For detailed information Abderhalden's *Biochemisches Handlexikon* (1911-1915) should be consulted.

In addition to these there is an excellent series of English monographs on biochemistry published by Longmans, Green & Co., and embracing fats, enzymes, proteins, etc.

LIST FOR A MORE COMPLETE SEARCH

If it is desired to make a more complete search of the literature, the following journals should be consulted:

1. Chemical Abstracts (1907 —).
2. Chemisches Centralblatt (1830 —).
3. Hoppe-Seyler—*Zeitschrift für physiologische Chemie* (1877 —).
4. Maly—*Jahresbericht über die Fortschritte der Tierchemie* (1871 —).
5. Centralblatt für Biochemie.
6. Centralblatt der exp. Medizin.
7. Koch—*Jahresbericht über Gährungs-Organismen* (1890 —).
8. Hofmeister—*Beiträge über chemische Physiologie und Pathologie*.
9. Biochemische Zeitschrift (1906 —).

Chemical Abstracts now makes a very complete review of work in this field. The earlier work is to

be found by consulting the volumes indicated under lists (g) and (h).

INORGANIC AND MINERAL CHEMISTRY

Unlike the literature of organic chemistry, where we have in Beilstein a "first aid" for the majority of inquiries, that of inorganic and mineral chemistry is scattered throughout the journals, books, monographs, etc.

In the first place, for reference to the general literature, the chemist should consult in the order named:

- (p) 1. Gmelin-Kraut—*Handbuch der anorganischen Chemie* (5 vols., 1907-1914).
2. Hofman—*Dictionary of the Inorganic Compounds* (16 vols., 1910-1915).
3. Abegg—*Handbuch der anorganischen Chemie* (4 vols., 1905-1913).
4. Moissan—*Traite de Chimie Minerale* (5 vols., 1904-1906).
5. Dammer—*Handbuch der anorganischen Chemie* (5 vols., 1898).
6. Roscoe and Schorlemmer—*Treatise on Chemistry* (2 vols., 1911-1913).
7. Remsen—*Inorganic Chemistry* (5th Ed., 1907).
8. Molinari—*General Industrial Chemistry* (trans. Pope, 2 vols., 1912-1913).
9. Mellor—*Modern Inorganic Chemistry* (1912).

while other volumes of interest are:

10. Thorpe—*Dictionary of Chemistry* (5 vols., 1912-1913).
11. Watts—*Dictionary of Chemistry* (4 vols., 1911-1914).
12. Wurtz—*Dictionnaire de Chimie pure et appliquée* (7 vols., 1892-1908).
13. Stähler—*Handbuch der Arbeitsmethoden in der anorganischen Chemie* (1913).

In addition the following journals should be reviewed:

- (q) 1. Chemical Abstracts (1907 —).
2. Journal Chemical Society, Transactions and Abstracts (1849 —).
3. Chemisches Centralblatt (1830 —).

In general a good plan to follow is first of all to review thoroughly these three journals, list (q), and then to proceed, according to the nature of the subject under review, to those journals which specialize in this field.

MINING AND METALLURGICAL CHEMISTRY

The chemist looking for specialized information will have to seek the same in a variety of text-books and publications, for example:

- (a) *Production of Metals*.
- (r) 1. Hofman—*General Metallurgy* (1913).
2. Roberts-Austen—*An Introduction to the Study of Metallurgy* (6th Ed., 1910).
3. Roberts-Austen—*Metallurgy of the Common Metals*.
4. Fulton—*Principles of Metallurgy* (1910).
5. Schnabel—*Handbook of Metallurgy*, Trans. H. Louis, 2 vols. (1905-1907).
6. Schnabel—*Lehrbuch der allgemeinen Hüttenkunde*, 2nd Ed., (1903).
7. Mineral Industry (1892 —).

and a variety of special treatises on individual metals such as

- Peters—*Copper Smelting*.
Hofman—*Metallurgy of Copper*.
Clennell—*The Cyanide Handbook*.
Hofman—*Metallurgy of Lead*.
Ingalls—*Metallurgy of Zinc and Cadmium*.
Stoughton—*Metallurgy of Iron and Steel*.
Rose—*Gold*.

(b) *Properties of Metals and Alloys*.

- (s) 1. Guertler—*Metallographie* (1912-1913).
2. Giua—*Chemical Combination Among Metals* (1918).
3. Howe—*Metallurgy of Steel*.

4. Howe—The Metallography of Steel and Cast Iron (1916).
5. Howe—Iron, Steel and Other Alloys (1906).
6. Law—Alloys and Their Industrial Application (1909).
7. Thurston—Treatise on Brasses, Bronzes, and Other Alloys and Their Constituent Metals.
8. Desch—Metallography (2nd Ed., 1913).
9. Ruer-Matthewson—The Elements of Metallography.
10. Sauveur—Metallography of Iron and Steel.

The following journals are devoted essentially to the subjects of mining and metallurgical chemistry:

(c) *Mining Chemistry.*

- (t) 1. Engineering and Mining Journal (1869 —).
2. American Institute of Mining and Metallurgical Engineers—Bulletin and Transactions (1871 —).
3. Mining and Scientific Press (1848 —).

(d) *Metallurgical Chemistry.*

- (u) 4. Chemical and Metallurgical Engineering (1902 —).
5. Journal of Institute of Metals (1909 —).
6. Internationale Zeitschrift für Metallographie (1911 —).
7. Iron Age (1834 —).
8. Journal Iron and Steel Institute (1869 —).
9. Brass World and Platers' Guide (1905 —).
10. La Metallurgie (1868 —).
11. Stahl und Eisen (1881 —).
12. Berg- und Hüttenmännische Zeitschrift—formerly Glückauf (1865 —).

(e) *Applied Electrochemistry.*

- (v) 1. Transactions of American Electrochemical Society (1902 —).
2. Transactions of the Faraday Society (1905 —).
3. Electrical World (1883 —).
4. Zeitschrift für Electrochemie (1894 —).
5. Chemical & Metallurgical Engineering (1902 —).

The one journal devoted essentially to inorganic chemistry is *Zeitschrift für anorganische Chemie* (1892 —), while information of value is often to be found in *Zeitschrift für angewandte Chemie* (1887 —).

This is not intended to serve in any sense as a complete guide to the subject, but only as a general outline which will, it is believed, serve as a useful help and general guide. The ability to search the literature rapidly and efficiently is in part a question of experience especially as regards the various "short cuts" which can only be effected as a wider grasp of the field is acquired.

SPECIAL LITERATURE FOR SPECIFIC INFORMATION

There is, in connection with each particular group, a certain definite territory consisting of special monographs, dissertations, journals, encyclopedias, etc., and the chemist will naturally direct his attention to them for specific information.

The abstract journal of the American Chemical Society is now covering the entire field in very complete fashion.

Certain of the journals have changed their names at various times—a fact to be borne in mind in reviewing the earlier literature. Furthermore the periodical indexes vary considerably as to the periods abstracted, and with regard to this point the chemist should consult the *Catalogue of Scientific and Technical Periodicals* (1665-1895), 2nd Ed. (1897), by Bolton, published by the Smithsonian Institution.

GENERAL INDEXES

For information regarding titles and dates of publication of books, monographs, etc., on chemistry and

allied subjects the following general indexes should be consulted:

1. Roorbach, O. R.—*Bibliotheca Americana* (1820-1861).
2. Kelly, J.—*American Catalog of Books published in U. S. from Jan., 1861, to Jan., 1871.*
3. *Publishers Weekly—American Catalog of Books* (1876-1910).
4. *United States Catalog—Wilson & Co.* (1900 —).

The last named is a five-yearly compilation of the "Cumulative Book Index"—Annual Catalog published by Wilson & Co.

In order that a technical chemist may keep up to date it is advisable that he should read regularly at least four or five journals, for example:

1. *Journal of the American Chemical Society.*
2. *Chemical Abstracts.*
3. *Journal of Industrial and Engineering Chemistry.*
4. *Chemical and Metallurgical Engineering.*
5. *Journal of the Society of Chemical Industry.*

The first two will give the chemist a fairly complete knowledge of the scientific chemical work being carried out in this and other countries, while the third and fourth will provide him with information on recent work and developments being carried out along technical lines. The fifth is valuable as a reference journal for information relating to patented processes, both here and abroad, and which are reviewed at greater length than in *Chemical Abstracts*.

The author wishes to acknowledge his appreciation of the kindness of the following gentlemen in favoring him with their criticism, suggestions and advice:

Dr. Colin Fink, Director Research Laboratories, Chile Exploration Copper Company, New York City; Dr. Roger Brunel, Professor of Chemistry, Bryn Mawr College, Bryn Mawr, Pa.; Mr. W. A. Hamor, Assistant Director Mellon Institute of Industrial Research, Pittsburgh, Pa.

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Manganese Ore

The United States Tariff Commission has recently completed the assembling of information on the manganese ore mining industry and has prepared an analysis of the competitive position of the United States in the manganese industry of the world. Among interesting facts recorded are the following:

Domestic production of high-grade (i.e., 35 per cent or more manganese) ore used largely for making ferro-manganese increased from 4,063 tons in 1913 to about 294,000 tons in 1918. Production of low-grade (less than 35 per cent manganese) ore, used partly for making spiegel and partly smelted direct in iron furnaces, increased from 85,588 tons in 1913 to over 1,079,000 tons in 1918. The number of shippers of high-grade ore in 1918 had increased from 75 in 1917 to about 210.

Manganese mining on a large scale in the United States, however, is an artificial industry. The domestic ore is low grade, obtainable in small lots only, and variable in character. Aside from the higher cost of domestic ore as compared with the foreign product, any large dependence on domestic supplies involves the rapid depletion of our limited reserves.

The foreign resources are in some instances practically inexhaustible, are high grade and are more easily mined than the domestic deposits. The average grade of imported ore is 45 to 55 per cent manganese, compared with domestic "high grade" running 35 to 45 per cent.

Use of Army Gas Masks in Atmospheres Containing Sulphur Dioxide*

Adequate Protection Obtained From Army Gas Masks in the SO₂ Industries — Physiological Effect of Sulphur Dioxide — Canisters: Duration, Special Fillings and Sizes — Limitation of Gas Masks

BY A. C. FIELDNER AND S. H. KATZ

THE use of toxic gases in warfare has led to the development of an entirely new type of respiratory appliance, namely, the gas mask, which promises to fill a long-felt want in the chemical and metallurgical industries. Heretofore, workmen around plants using processes in which acid fumes are given off made shift to protect themselves, in more or less inadequate manner, by wearing moistened handkerchiefs, or respirators containing wet sponges, over the mouth and nose. The close of the war now makes available the army type gas mask, which is admirably adapted to filtering out many chemical fumes and acid vapors from inspired air, provided the concentration of gas is low (less than 1 or 2 per cent).

The possibility of using army masks around smelters and sulphide roasters for protecting the workmen from sulphur dioxide fumes was suggested, almost a year ago, by Mr. George S. Rice, chief mining engineer of the Bureau of Mines, and at his request several patterns of army masks were tested in various concentrations of sulphur dioxide to determine the degree of protection afforded. Owing to the pressure of military work and the inability of obtaining masks for industrial use, this investigation was not completed until after the signing of the armistice. The work is now completed, and the results are given in this publication.

PHYSIOLOGICAL EFFECT OF SULPHUR DIOXIDE

Sulphur dioxide is an irritating, irrespirable gas, relatively non-toxic as compared to carbon monoxide or oxides of nitrogen. There is very little danger from sulphur dioxide poisoning, as the fumes are so irritating that the victim is compelled to seek air at once. In extreme cases¹ of very high concentrations, when the victim cannot retire from the fumes, death may result from respiratory spasms and asphyxia. Ordinarily, however, workmen exposed for some time to a mild degree of sulphur dioxide poisoning complain of headache, anorexia, spasmodic cough, sneezing, hemoptysis, bronchitis, constriction of chest, gastro-intestinal disorders, conjunctivitis, smarting of eyes, lachrymation and anemia. For these symptoms workmen soon acquire toleration. The inhalation of large quantities of sulphur dioxide produces ulceration of the mucous membrane.

The Selby Smelter Commission² made a thorough investigation of the effect of various concentrations of sulphur dioxide on the senses of a number of persons.

The average results of these tests are tabulated below:

Three to 5 parts per million (by vol.)—Plainly or faintly detectable by smell or taste.

Eight to 12 parts per million (by vol.)—Slight throat irritation and tendency to cough.

Twenty parts per million—Very distinct throat irritation, coughing, constriction of chest, lachrymation and smarting of eyes.

Fifty parts per million—More pronounced irritation of eyes, throat and chest, but possible to breathe several minutes.

One hundred and fifty parts per million (by vol.)—Extremely disagreeable but could be endured for several minutes.

Five hundred parts per million—So acutely pungent as to cause a sensation of suffocation, even with the first breath.

With no concentrations of less than 50 parts per million was there produced any feeling of nausea, and the tendency to nausea with the highest concentrations was only slight.

The authors repeated some of these experiments with substantially the same results; 370 parts per million (0.037 per cent) could be endured for only one-half minute.

TESTS OF ARMY GAS MASKS

Early French Type:—The early French type of mask, shown in Fig. 2, consists of 40 thicknesses of cheesecloth, fashioned to fit over the entire face, from neck over chin to the hair above the eyes from ear to ear. Suitable rubber web bands held the mask closely to the face. Cellophane eyepieces were built into the mask at the eyes. The 10 outside layers of cheesecloth were impregnated with an unsaturated oil; the next 10 layers held an alkaline material; the next 10, hexamethylene tetramine; and the 10 next the face, nickel sulphate. The tests were made in a large airtight gas chamber, in which the sulphur dioxide atmosphere was produced by burning sulphur. The air was well stirred by two electric fans, running continuously throughout the tests. The concentration of sulphur was determined by titration with iodine. After the required concentration was reached, two observers, wearing carefully adjusted masks, entered the room. The results are given in Table I.

From the experiments in Table I it may be concluded that an atmosphere containing 0.16 per cent of sulphur dioxide may be safely entered and work performed by a person wearing a mask such as used in the experiments. Even though a mask were worn, it would be dangerous to attempt work in an atmosphere containing 0.20 per cent of sulphur dioxide, unless means of immediate exit were at hand and an observer watching from a place of safety to effect a rescue in case of necessity.

Prolonged exposure to sulphur dioxide, even in moderate concentrations, is undoubtedly injurious. Five

*Published with the permission of the Director, Bureau of Mines.

¹Thompson, D. Gilman, M. D., "The Occupational Diseases." D. Appleton & Co., New York, 1914, p. 360.

²Holmes, J. A., Franklin, E. C., and Gould, R. A., "Report of the Selby Smelter Commission," Bureau of Mines, Bull. 98, pp. 172-175.

hours after the close of the above experiments, the observer who had been most exposed felt a soreness through the lungs and throat and the voice was slightly husky. The discharge from the nose was increased,

TABLE I—EFFECTS PRODUCED BY ATMOSPHERES CONTAINING VARIOUS PROPORTIONS OF SULPHUR DIOXIDE ON PERSONS WEARING FRENCH PATTERNED MASKS, FIG. 2.

Test No.	Time	SO ₂ by Iodine Per Cent	Effect on Wearer of Apparatus in Atmosphere
..	2:15	0.57	
1	2:31:00 to 2:31:45	....	Sulphur dioxide penetrated masks. The eyes could feel it, but were not disturbed much. The biting was severe in the air passages of the nose and throat. It could also be felt in the bronchial tubes and lungs. Observers could remain in this atmosphere only 45 seconds.
..	2:46	0.43	
2	2:58:00 to 3:03:00	....	The observers could just bear the sulphur dioxide that came through the masks. The biting in the air passages extended all the way to the lungs. Coughing was caused. The eyes were not bothered. The breathing was deep and difficult. In case of necessity, one could probably travel 1 mile in this condition. It was thought best not to remain in this atmosphere longer than 5 minutes. After coming into the fresh air, all the sulphur dioxide disappeared from the mask after three inhalations.
3	3:24:00 to 3:27:00	0.24	At first, one of the masks leaked at the sides, so that the eyes were bothered. After fixing this, the atmosphere was much better. The biting in the air passages was not so severe, but coughing was caused. It is probable that one could stand this atmosphere one hour, in case of necessity.
4	4:00	0.16	No difficulty was experienced in this atmosphere. The sulphur dioxide was noticeable and the throat was slightly irritated, but work could be done with hardly more trouble than that due to the mask itself.

and was slightly pink from blood. The next day he felt normal.

DISCOMFORT CAUSED BY THE MASK

The French type mask is an unpleasant apparatus to wear at best, although it imposes no marked hardship on the wearer. The face is heated, and the atmosphere breathed necessarily contains much exhaled air, and is hot and close. To determine the composition of the atmosphere within a mask while worn by a person at rest, two samples of gas were taken from a point $\frac{1}{2}$ in. above the nostrils, the first, during periods of exhalation, the second, during periods of inhalation. The results are given in Table II.

TABLE II. COMPOSITION OF ATMOSPHERE WITHIN MASK WHILE WORN IN PURE AIR

No.	CO ₂	O ₂	N ₂	
1	2.90	17.41	79.69	Sample taken during exhalation.
2	1.37	19.15	79.48	Sample taken during inhalation.

These tests show the bad effect of the large "dead space" in this type of mask. Even while at rest the wearer has to inhale 1.37 per cent of carbon dioxide, which contributes to the oppressive feeling produced by this mask. Aside from the question of rebreathing a certain proportion of exhaled air, this type of mask furnished so little protection against sulphur dioxide that it is of no practical value for use in the industries.

MOUTHPIECE TYPE U. S. ARMY MASK

The standard U. S. Army gas mask of the mouthpiece type is shown in Figs. 4, 7, 8 and 9. It consists essentially of a facepiece of rubberized fabric, impermeable to gas, connected to a canister containing the absorbents by a short length of flexible rubberized tubing. The wearer breathes through a rubber mouthpiece, the nose

being closed by a spring clip, mounted on the inside of the mask. Leakage through the facepiece will only affect the eyes of the wearer, as the gas cannot enter the lungs. The inhaled air enters the bottom of the canister through a disk valve that closes on exhalation, the expired air passes out through a rubber flutter valve, projecting downward from the metal elbow tube just outside the facepiece.

The Type "F" standard army canister shown in section in Fig. 8 is 5½ in. high and contains 42 cu. in. of a mixture of cocoanut charcoal and "purple" soda lime and two cotton wadding filter pads, placed at one-third and two-thirds distance from the bottom, respectively. One of the authors, wearing this outfit, entered the gas chamber containing a concentration of 0.46 per cent sulphur and remained one hour, without detecting any gas whatever, except on one occasion, when the mask was disarranged, and then sulphur dioxide penetrated to and irritated the eyes. On adjusting the mask and clearing the facepiece, the gas disappeared, and no discomfort whatever was experienced thereafter from that source. During a part of the time, work was done on a bicycle dynamotor.

More sulphur was then burned, until a fog was produced in which objects could not be distinguished at distances beyond 4 ft. Analyses showed that the concentration was 1.17 per cent sulphur dioxide. No discomfort of any kind could be felt by the wearer, other than that due to the mask itself.

LIFE OF CANISTERS IN HIGH CONCENTRATIONS

Tests were made to determine the life of the standard Type "F" army canister in an atmosphere containing 5 per cent sulphur dioxide. The gas was put up in the chamber from a cylinder of liquid sulphur dioxide, attached to the chamber. Analyses of the chamber gas were made by drawing two liters of gas through a standard iodine solution and titrating back with standard sodium thiosulphate solution. Twenty canisters were tested, in lots of 10 each. The men did not enter the chamber, but were seated on the outside, wearing the facepieces, which were connected to iron pipes that passed through the walls of the chamber. The canisters were attached to the other end of these pipes on the inside of the chamber. As soon as a man detected gas coming through his canister, as shown by throat irritation, the time was taken, and the canister was considered exhausted.

Tested under these conditions, the 20 canisters served to remove all sulphur dioxide for periods of time varying from 18 to 41 min. The average service time was 29 min. The large variation in service time for the individual canisters was due, in part, to differences in the canister fillings, but mostly to differences in the breathing rates of the men. Individuals breathe different amounts of air. A small man may breathe only 5 liters per minute when at rest, while a large individual may require 10 or 12 liters. The average rate of a number of men, when at rest, is in the neighborhood of 8 liters per minute. Moderate exercise increases the rate to approximately 30 liters, and vigorous exercise causes a breathing rate of 60 to 70 liters. Hence, the efficient life of a gas mask canister is proportionately less when the wearer is engaged on continuous work.

In making these tests with high percentages (5.07 per cent) of sulphur dioxide, the canisters became quite warm after 15 min. use. A temperature of 80 deg. C.

was noted in some of the canisters. This elevated temperature made breathing rather uncomfortable toward the end of the test; however, all the men were able to continue breathing through the canisters until the gas finally penetrated the absorbent.

PRACTICAL TESTS BY ANACONDA COPPER MINING CO.

Several army masks of the mouthpiece type, Figs. 4, 7, 8 and 9 fitted with standard Type "F" canisters, containing soda lime and charcoal mixture with two cotton wadding filter pads, were tested under practical conditions by Mr. James Kane Murphy, assistant superintendent of the Washoe Reduction Works of the Anaconda Copper Mining Co., at Anaconda, Mont. The following paragraphs are quoted from his report:

"On Oct. 23, 24 and 25, we had considerable repair work to do on one of our Cottrell treaters; this treater takes one-quarter of the gas from roaster No. 2. During the repair work on this treater, it was shut off as tight as possible, but there was such a leakage of SO_2 gas that it was impossible for a man to enter the treater to do any work. The iron workers repairing this treater were able, two at a time, to put on these masks, and do their repair work in the treater. The men stayed in about 20 min. at one time; by that time, the heat and dust caused them to come out, but the masks were very satisfactory and work could be done with them by proceeding slowly.

"One test on these masks was performed in the No. 2 roaster ventilating tunnels when flotation calcine was drawn into cars ahead of the man with the gas mask on. It is absolutely impossible for a man without a mask even to attempt to stay in this place. Most of the dust coming from the cars, which were being loaded ahead of the man with the gas mask, will pass through 200 mesh, but none of the men wearing a mask in this place had any trouble with dust.

"A third mask was tested in a very high concentration of gas. The mask was carefully adjusted about the face and the person making the test was in an atmosphere containing about 5 per cent SO_2 . Mr. E. A. Bernard, superintendent of calcining, personally put the mask on in this atmosphere, besides two other men. All decided that the gas came through the canister. This test was made on gas from the top hearth of an Anaconda type roaster furnace. The hearths on this furnace are similar to a Wedge roasting furnace. A steady wind was blowing against the east side of the furnace, so all doors on the top floor were opened, thus forcing a good part of the furnace gases out of the west doors. The testers stood as close as possible to the doors through which the gas came. This gas contains some SO_2 , considerable moisture, dust, and some As_2O_3 , besides the SO_2 .

"If possible, we would like to have two more canisters for further testing of these masks, as they have proved to be very valuable in certain places, from the industrial point of view."

This reports that the simple army gas mask is exceedingly valuable around sulphide roasters and in fact any industry in which sulphur dioxide is given off. The third test, in which gas penetrated the canister, illustrates the limitation of this type of protective appliance. It must not be used in too high a concentration of gas. In this case, the percentage of SO_2 was probably higher than 5 per cent, as tests at the American University Experiment Station of the Chemical Warfare Service

have shown that the standard army canister will remove 5 per cent of sulphur dioxide for at least 15 minutes.

SPECIAL CANISTER FILLING FOR SULPHUR DIOXIDE

The standard army canister contains 40 per cent soda lime and 60 per cent charcoal. The charcoal is of less value in absorbing sulphur dioxide than soda lime. Hence, for use in sulphur dioxide and dust an all soda-lime canister with cotton wadding filter pads will last from 50 to 100 per cent longer than the standard canisters used in the Anaconda tests. This is shown in the comparative canister tests with different fillings against $\frac{1}{2}$ per cent SO_2 .

TABLE III—SERVICE TIMES OF CANISTERS WITH STANDARD AND SPECIAL FILLINGS

SO_2 Concentration, 0.5% or 13.0 Mg per Liter; Relative Humidity, 50%; Average Temperature, 26° C.

Canister Filling	Service Time in Minutes	
	First Trace of Penetration	0.005 Per Cent SO_2 in Effluent
*Standard, 50 per cent charcoal, 40 per cent soda lime.....	32	36
Special, 100 per cent charcoal.....	7	57
Special, 100 per cent soda lime.....	54	..

* Average of five canisters tested.

The life or service time of the canister is the time in minutes during which all traces of SO_2 are absorbed by the canister. The breakdown of the canister is shown by the change in color of a sensitive potassium iodide-starch solution through which the effluent air from the canister is bubbling during the test.

ADVANTAGES OF LARGER CANISTER FOR INDUSTRIAL USE

The standard army canister described in the foregoing tests contains 42 cu.in. of absorbent, weighs 1½ lb. and has a resistance to flow of 3½ to 4 in. water column at 85 liters per minute flow. This high resistance obliges men to work rather slowly while wearing the mask. A second disadvantage to which Mr. Murphy has called special attention is the short service time of the absorbent.

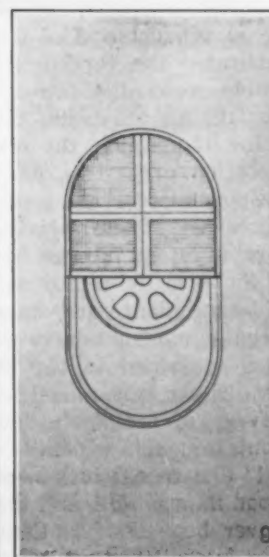
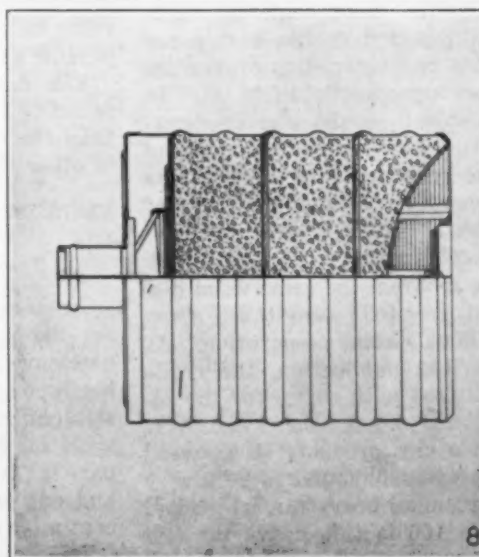
Both of these defects can easily be remedied by increasing the cross-sectional area of the canister without increasing the height in proportion.

RECOMMENDED TYPE OF GAS MASK

Although the mouthpiece type of mask was found fairly satisfactory in practical use, it is believed that the later type of Tissot mask, Figs. 5 and 6, in combination with a 100 cu.in. soda-lime canister will prove the best outfit for exclusive use in sulphur dioxide and acid gases. The elimination of mouthpiece and noseclip increases very materially the comfort, and enables the wearer to keep it on for hours at a time. The large eyepieces, held rigidly in proper position by the well-fitting substantial facepiece, afford a large angle of vision, thereby greatly increasing the efficiency of the workman wearing the mask. He should be able to do substantially the same amount of work as without the mask in a normal atmosphere.

OTHER INDUSTRIAL USES OF SULPHUR-DIOXIDE RESPIRATORS

Aside from the many metallurgical operations in which sulphur dioxide is given off, a respirator or gas mask designed for this purpose should be useful in sulphite pulp and paper mills; in sulphuric acid plants and



TYPES OF GAS MASKS USED IN WAR

1. Black veil with absorbent cotton saturated with sodium thiosulphate, carbonate and glycerine, effective against active gases such as chlorine. 2. Early French mask. 3. P. helmet saturated with NaOC_2H_5 —effective against phosgene. 4. British type mask, mouthpiece and wiping fold. 5 and 6. Tissot masks, air inlet at eye, no noseclip or mouthpiece. 7, 8 and 9. Sectional drawings of British type U. S. A. mask.

in fact for protection against any acid gas such as chlorine, phosgene, carbon dioxide, hydrocyanic acid, oxides of nitrogen and hydrochloric acid.

LIMITATIONS OF GAS MASKS

In closing this paper, the authors feel it necessary to issue a most emphatic warning against the indiscriminate use of gas masks for any and all purposes. The soldiers in the army have been taught that their gas mask will protect them absolutely against any gas the enemy may put up. These men, on returning to civil pursuits, carry this idea with them. They will not realize that the extremely poisonous gases used in warfare are chemically active, and, therefore, combine readily with the absorbents of the gas mask. Furthermore, outdoor gas concentrations seldom exceed a few hundredths of 1 per cent. Some of the gases which are successfully absorbed by the mask at these battlefield concentrations will immediately penetrate it when present in quantities of 1 or 2 per cent. In fact, the army gas mask is useless against many of the most common industrial gases, as for example, carbon monoxide, ammonia, natural gas, producer and blast-furnace gas, mine gases, coal and water gas, and probably any gas when occurring in concentrations exceeding five per cent.

In such cases the self-contained oxygen breathing apparatus must be used, as the gas mask does not supply any oxygen whatever.

In view of these serious limitations, the gas mask should be used only with the advice of an expert who has a thorough understanding of the limitations of this apparatus.

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Flotation Experiments on Hardwood Tar Oils

BY L. F. HAWLEY¹ AND O. C. RALSTON²

THIS PAPER describes a continuation of the work started by Palmer, Allen and Ralston* on the testing of various flotation oils prepared from wood distillation products, especially the more neglected hardwood products. The tests reported in the first paper indicated the very desirable characteristics of various crude wood distillation products as flotation oil. In continuing the tests, the object sought was to determine, if possible, the relation between composition and flotation properties, or the constituent or constituents responsible for the good quality. Although neither of these points was satisfactorily settled, considerable information of interest was obtained.

Samples 106 to 109 were all from the same wood distillation plant, and except for 107 were taken from regular plant products without special preparation. As was explained in the previous publication, the crude settled tar is commonly distilled with steam for the recovery of the acetic acid and wood alcohol which it contains; this produces two oily products—the “wood oil” distillate, which was previously found to be a very good flotation oil, and the residual heavy tar, which had never been tested. Sample 106 is this heavy tar and 108 is the wood oil for comparison. Sample 107 is the

heavy oil obtained by distilling a tar like 106 until a temperature of 265 deg. C. is reached. Sample 109 is a commercial sample of dissolved tar, the residue obtained after distilling the crude pyroligneous acid. Sample 110 is another heavy tar like 106, but obtained from a different commercial plant.

RESULTS OF COMPARISON

A comparison of this series shows that the three crude tar products produced in the regular course of operation of most hardwood distillation plants, viz., “wood oil,” “heavy tar” and dissolved tar, are all better flotation oils than the distilled heavy oil which can be obtained by further distilling the “heavy tar.” The regular crude tar-products are all very good and very much alike.

Samples 113 and 114 were from the same plant as 110. They represent the oils which settle out in the crude alcohol storage tank and in the alcohol refining still respectively. No. 113 was a heavy oil with gravity 1.021, and No. 114 a light oil with gravity 0.931. Neither of these oils was as good as the tars and wood oils, but they gave results much the same as the distilled oil No. 107, which they resemble somewhat in composition. Sample 115 was a dissolved tar similar to 109 except that it was made from resinous wood (southern yellow pine lightwood) instead of hardwood. It is seen to be slightly inferior to the hardwood dissolved tar. This material is not of much interest commercially, since only very small quantities are produced.

TESTS MADE ON PITCH

As already stated, the tests on samples 106 to 109 showed that the oil distilled from heavy tar was inferior to the heavy tar itself. This suggested that the pitch which is the other constituent of the heavy tar (heavy tar = pitch + heavy oil) might be the constituent largely responsible for flotation properties. A series of tests was carried out with samples of pitch dissolved in low-boiling redistilled wood oil (No. 144), acetone (No. 150) and carbon tetrachloride (No. 151), together with samples of the pure solvents for comparison. All of these tests showed that pitch dissolved in solvents of low flotation value added considerably to the flotation value of the solvent, but in no case gave an oil comparable with the tar from which the pitch was prepared.

The natural combination of pitch and volatile oils found in hardwood tar is therefore a better flotation oil than the volatile oils alone, or than the pitch dissolved in other volatile oils of lower flotation value.

TESTS TO DETERMINE HOW MUCH PITCH IS NECESSARY TO GIVE MAXIMUM FLOTATION VALUE TO A HARDWOOD TAR

Another series of samples, Nos. 141-144, was prepared for the purpose of determining how much pitch was necessary to give the maximum flotation value to a hardwood tar. The series consisted of end members of straight settled tar (about 40 per cent pitch) and distilled oil (no pitch), and intermediate members of one part tar to one part distillate (about 20 per cent pitch) and one part tar to two parts distillate (about 13 per cent pitch).

It is difficult to explain these results on a basis of pitch content, since the samples with 40 per cent pitch and the 13 per cent pitch seem to be about the same, and both better than the 20 per cent and zero pitch sam-

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*Trans., Am. Inst. Min. Eng., 1916, p. 1387.

ples. It is very apparent, however, that the crude settled tar without any distillation treatment is a much better flotation oil than the distillate obtained from it up to a temperature of 260 deg. C., and as good an oil as can be obtained by mixing the distilled oil with the original tar. This conclusion corresponds well with that in regard to the relation between the heavy tar (tar from which light oils had been removed) and the oil which can be obtained from it by distillation (heavy oils only).

REMOVAL OF ALKALI-SOLUBLE MATERIAL SEEMS TO IMPROVE OIL FOR FLOTATION PURPOSES

Samples Nos. 146 and 147 were prepared and tested to settle a question which arose in connection with the operation of a plant producing distilled tar oil for a flotation oil. It was desired to extract part of the alkali-soluble material from a part of the distilled oil for use in manufacture of medicinal beechwood creosote, but it was not known what the effect of such partial extraction might be on the value of the residual oil for flotation purposes. Sample 146 was a straight distilled oil with boiling points 180-260 deg. C., while No. 147 was the same except that 40 per cent of the alkali-soluble material of the fraction 180-260 had been removed. The removal of this alkali-soluble material seems to have improved the value of the oil for flotation purposes, and this result indicates that the raw material for medicinal creosote can be removed from hardwood tar flotation oil without diminishing the value of the latter.

COMMERCIAL TESTS MADE

In order that the laboratory tests might be further checked, two of the promising oils were obtained in larger quantity and large samples sent to a number of prominent metallurgists in charge of representative plants with the request that they give them commercial full-scale tests in their mills, or semi-commercial tests in single units. The Anaconda Copper Co. tested the oils for both their copper and their zinc ores. The Bunker Hill and Sullivan tested the oils for their silver-lead ore, and a number of other operators did likewise. The oils did not meet with universal success in the treatment of all ores, but were found to be very satisfactory for some of them, and in a number of cases seemingly the full equivalent of the more expensive pine oils. The two oils tested were the commercial (hard-) wood oil (similar to No. 108) and the crude settled tar (like No. 141), both of which are produced in nearly all ordinary wood distillation plants, and whose recovery does not involve much special machinery.

REPORTS ON COMMERCIAL PLANT TESTS

The following extracts from three reports on commercial plant tests indicate the results obtained more specifically:

A. "I am enclosing a report . . . on experiments with Nos. 1 and 2 hardwood oils. . . . It would seem that they are as effective on our ores^a as steam distilled pine oil."

No. 1 is the same as No. 141 in Table I. No. 2 is the same as No. 108 in Table I.

B. "Both oils acted much the same on copper ore, but in the case of tests on zinc ore the tar did not give as good results as the oil. . . . These oils are

worthy of consideration for use as flotation reagents. They would not give good results if used alone, but fair results should be obtained when used in conjunction with kerosene acid sludge."

C. "We have tested the sample of hardwood oil^c which you recently supplied with the following results:

Date	Hours Run	Assay Concentrate		Assay Tailings		Extraction	
		Pb	Ag	Pb	Ag	Pb	Ag
14	20	44.9	24.5	1.21	0.60	84.0	83.6
15	24	49.2	26.7	1.28	0.60	82.5	83.1
16	24	48.7	25.8	2.21	1.00	69.1	71.5
17	24	52.5	26.5	1.52	0.70	78.9	80.7
18	24	51.4	25.2	1.40	0.70	80.7	80.3
19	24	45.9	23.1	0.98	0.40	86.8	89.1
20	12	47.2	24.8	0.70	trace	90.2	94.5
Average.....		48.4	25.3	1.38	0.63	81.1	85.0

TREATMENT IN REGULAR MILL OPERATION

"This was in regular mill operation and no effort was made to get especially good results. We had considerable trouble feeding the oil, as our feeding devices are all of the drip type. This, of course, would be easy to remedy if we used this type of oil. The oil consumed over the period averaged 0.2 lb. per dry ton of feed. The results compare very favorably with those obtained from the use of pine oil and creosote."

TABLE I—RESULTS OF FLOTATION TESTS *

Sample No.	Description of Oil Used	Pb		Zn	
		Per Cent in Concentrate	Per Cent Extraction	Per Cent in Concentrate	Per Cent Extraction
106	Heavy tar.....	21.6	88.1	24.7	88.4
107	Oil, from 106 up to 265 deg. C.....	24.8	85.5	18.3	66.6
108	Commercial "wood oil".....	25.6	84.1	27.8	89.3
109	Dissolved tar.....	26.6	85.5	27.8	89.1
110	Heavy tar.....	19.0	92.3	18.9	87.4
113	Light oil from alcohol still.....	22.6	85.0	22.6	63.7
114	Heavy oil from alcohol still.....	20.9	73.8	20.2	67.0
115	Dissolved tar from pine wood.....	16.9	81.0	19.4	90.2
141	Crude settled tar.....	21.9	75.4	32.8	75.3
142	1 part 141 and 2 parts 144.....	24.5	78.8	32.3	61.5
143	1 part 141 and 1 part 144.....	27.8	67.0	32.8	54.5
144	Distillate from 141.....	26.6	59.8	30.8	33.5
146	Distillate 180-260 deg. C.....	22.1	69.5	23.1	57.0
147	146 partly extracted with alkali.....	17.0	75.0	20.7	74.5
149	Pitch dissolved in redistilled low-boiling wood oil.....	22.5	33.8	29.8	28.0
149B	Redistilled wood oil.....	24.3	31.2	37.4	23.7
150	Pitch dissolved in acetone.....	29.1	28.7	31.0	17.8
150B	Acetone.....	29.5	12.8	13.5	15.3
151	Pitch dissolved in carbon tetrachloride.....	29.5	59.5	32.5	19.0
151B	Carbon tetrachloride.....	31.4	32.8	12.2	0.0

*All the figures given in this table were obtained by tests in alkaline circuit. All the samples were tested also in acid and neutral circuit, but in most cases the results obtained with alkali were very much better, and the above figures are considered to give the best comparison of the different oils. As mentioned in our first paper, the tests were performed in a laboratory Janney flotation testing machine on a mixed zinc-lead sulphide ore.

CONCLUSIONS

We have found that some of the crude hardwood distillation products, as now prepared in many plants, are adapted to satisfactory flotation of a number of ores. An attempt to determine which constituents of the oils were of most value in flotation gave negative results, and it seems that the crude products are as a rule better than any of the fractions or refined products made from them. In other words, a mixture of different oils is more likely to do good flotation work than any one product alone. In spite of the fact that there is considerable prejudice against all resinous wood distillates which contain pitch, the statement being made that they spoil the "selection" of the oil and produce dirty flotation concentrate, we have not found hardwood pitch undesirable in most of the mixtures tested.

^aThe ore is a galena carrying silver.

^cThe same as No. 141 in Table I.

Determination of Uranium, Zirconium, Chromium, Vanadium and Aluminium in Steel—II

BY CHARLES MORRIS JOHNSON

TO DETERMINE the amount of aluminium and zirconium in steel dissolve 4 g. of sample in 50 cc. of 1:3 H_2SO_4 diluted with 50 cc. of water. After action is over, filter off the insoluble residue, which is mainly carbides. Wash the carbides 25 times with dilute H_2SO_4 , wash. Call this filtrate and washings A. The insoluble carbides will contain some Al and Zr. Ash the same in a platinum crucible at a low red heat. Cool; add 6 cc. HF plus 6 cc. of 1:3 H_2SO_4 ; evaporate to thick fumes; cool; add a little water, heat until all sulphates are in solution and add latter to A. Dilute A to about 250 cc. volume with water and add 1:1 ammonia with constant stirring until the first appearance of a black precipitate forms. Add a few drops in excess. At this stage all the zirconium and aluminium have been precipitated with a very small percentage of the iron. Filter off at once and redissolve precipitate in 50 cc. of hot 1:1 HCl. Wash the paper with dilute HCl wash till it looks perfectly white. Concentrate the filtrate and washings to about 50 cc. volume and peroxidize with sodium peroxide till the solution is alkaline. This peroxidization is carried out in the following manner: add from a small porcelain spoon about 1 g. at a time of Na_2O_2 . Rinse off spoon into beaker with each addition of the peroxide and stir the solution each time, and so on until the solution is alkaline. By this process the volume reaches about 300 cc. by the time it is alkaline. Then add 5 g. of Na_2CO_3 ; bring it just to a boil and filter off the iron and zirconium. Wash precipitate with water about 25 times. The filtrate contains the aluminium. Redissolve the iron and zirconium in 50 cc. of hot 1:1 HCl and peroxidize again as before to remove the last traces of aluminium.

Add to the filtrate 1:1 HCl with constant stirring until turmeric paper does not change even to a faint brown when dipped in the solution, but red litmus paper gives an alkaline reaction. Keep cover on while adding the acid. Let aluminium settle for a few hours and after filtering it off, wash it about 40 times with ammonium nitrate wash. Redissolve the aluminium with hot 1:1 HCl, wash it with dilute HCl water. (Wash the papers also with water and burn off with the main precipitate, as some aluminium is liable to remain in the papers.)

To the filtrate and washings add 1:1 ammonia till slightly ammoniacal. Aluminium is precipitated. Now bring it to a boil, filter it off and wash it free of chloride. Burn it off in a weighed platinum crucible to a constant weight. Remove the silicon by evaporation with HF and a few drops of 1:3 H_2SO_4 ; again weigh as Al_2O_3 . Multiply by 0.53033 to calculate to metallic aluminium.

IRON AND ZIRCONIUM

The iron and zirconium on the filter are dissolved in 30 cc. of hot 1:3 H_2SO_4 diluted with 50 cc. of water. Wash the paper about 40 times with dilute sulphuric wash. Add to the filtrate 20 cc. of a saturated solution of Na_2HPO_4 (di-sodium phosphate); stir well. Add 1:1 ammonia slowly till a precipitate just starts to form. Zirconium phosphate comes down at this stage with very little iron, as the solution is still acid and

most of the iron is in solution. The more zirconium with the sample the less ammonia it is necessary to add before a precipitate starts to form. After a few hours, preferably over night, filter off the zirconium phosphate plus some iron phosphate, plus some silicon. Wash the phosphate with water 40 times. Burn it off in a weighed platinum crucible. Add about 10 drops of conc. sulphuric acid and 10 cc. HF. Evaporate just to SO_2 fumes. Transfer the insoluble residue into a beaker. The iron phosphate will be in solution as iron sulphate, while the zirconium phosphate is insoluble. Warm the solution for a while to redissolve the iron sulphate that may be separated out. Filter off the insoluble residue, wash it about 50 times with water and burn it off in the same platinum crucible. (Some of the zirconium may stick to the crucible and cannot be transferred to the filter.) Burn it to a constant weight and weigh as zirconium phosphate, using the original weight of the crucible gotten just before the zirconium phosphate plus a little iron phosphate was burned in it. Multiply by 0.3838 to calculate to zirconium.

Standards were prepared by adding a known weight of metallic test aluminium and ZrO_2 (zirconium alba) to a plain steel: treated the same way as the samples. The recoveries are accurate. See table below.

TEST MIXTURES OF Fe, Al, and Zr

- (1) Fuse ZrO_2 with potassium bisulphate, dissolve the melt in dilute sulphuric acid to get it in solution.
- (2) Dissolve metallic aluminium in 1:1 HCl; fume it with sulphuric acid. Dissolve in water to get it in solution.
- (3) Pour (1) and (2) into the sulphuric acid solution of the drillings of the plain steel.

Added	Recoveries	Found
0.015 g. aluminium		0.0164 g. aluminium
0.030 g. aluminium		0.0310 g. aluminium
0.050 g. aluminium		0.0495 g. aluminium
0.025 g. aluminium		0.0265 g. aluminium
0.0110 g. zirconium		0.0108 g. zirconium
0.0220 g. zirconium		0.0214 g. zirconium
0.0368 g. zirconium		0.0365 g. zirconium
0.0184 g. zirconium		0.0185 g. zirconium

Sample of so-called "zirconium steel" submitted to the author for analysis.
Sample A—Al, 0.41 per cent; Zr, 0.13 per cent; Si, 0.77 per cent.
Sample B—Al, 0.56 per cent; Zr, 0.17 per cent; Si, 0.75 per cent.

ALUMINIUM IN PLAIN STEEL

Dissolve on a low flame 5 or 10 g. of steel in 50 cc. 1:3 H_2SO_4 diluted with 50 cc. of water. After action is over, filter off the insoluble residue, which is mainly carbon and carbides, wash it 25 times with dilute H_2SO_4 , wash. Call this filtrate and washings A. The insoluble residue may contain Al, so it must be ashed in a platinum crucible at a low heat; cooled; 6 cc. of HF + 6 cc. of 1:3 sulphuric acid added; evaporated to thick fumes of SO_2 ; cooled; a little water added; heated to dissolve the sulphates, and the clear solution is added to A. Then dilute A to 250 cc. volume with water, and add slowly 1:1 ammonia with constant stirring, until the reddish precipitate changes to a blackish. All the aluminium is precipitated with but 3 or 4 per cent of the iron. Filter aluminium plus a little iron off at once; redissolve it in 50 cc. hot 1:1 HCl, pouring the acid back and forth until all the iron and aluminium is in solution. Wash the filter paper about 40 times with dilute HCl water. Peroxidize the filtrate with sodium peroxide until the solution changes red litmus paper to a blue. Add about 5 g. of sodium carbonate; bring it to a boil and filter off the iron. Wash the precipitate about 30 times with water.

If the pulp mixed with the precipitate is washed thoroughly no more aluminium will be left with the iron,

otherwise it is necessary to redissolve the iron in hot 1:1 HCl and make another peroxidation. To the filtrates add 1:1 HCl with constant stirring until turmeric paper does not change even to faintest brown when dipped into the solution, but red litmus paper turns slightly blue when dipped into it. Aluminium is precipitated at this stage. After a few hours, especially when aluminium per cent is low, filter off the precipitate and wash it about 40 times with ammonium nitrate, to remove the salts as far as possible. To free the aluminium from all sodium salts the aluminium is redissolved in 50 cc. hot 1:1 HCl. Wash filter 40 times with dilute HCl wash. (Wash the filter paper free of chloride with water and save it to burn with the main final precipitate, as aluminium is liable to remain in the filter.)

Precipitate the aluminium by adding 1:1 ammonia to the filtrate until faintly ammoniacal. Bring it to a boil and filter off the aluminium hydroxide. Wash it free of chloride with ammonium nitrate. Burn off in a weighed platinum crucible and blast it to a constant weight. Weigh it as Al_2O_3 plus SiO_2 . Remove the silica by evaporation with a few drops of 1:3 H_2SO_4 and 10 cc. of HF. The remainder is Al_2O_3 . Multiply by 0.53033 to calculate to aluminium.

ALUMINIUM RECOVERIES FROM STEEL

Weight of Steel Taken, G.	Aluminium Added, G.	Aluminium Found, G.
15	0.010	0.0102
10	0.020	0.0199
5	0.050	0.0508
5	0.030	0.0300
5	0.100	0.1005

Same weights of steel without any aluminium added were put through all of the foregoing operations and the blanks found were deducted from the above five samples.

Note: Dissolve the metallic aluminium in 1:1 HCl, fume it with 1:3 H_2SO_4 ; dissolve in water; add the aluminium sulphate solution to H_2SO_4 solution of the drillings, when making up standards, as metallic aluminium is only slightly soluble in 1:3 sulphuric acid,

CHROMIUM AND VANADIUM

For determination of small amounts of chromium and vanadium, dissolve 5 to 10 g. of steel in 50 cc. 1:3 H_2SO_4 , dilute with 50 cc. of water, using a 600 cc. beaker. After action is over, filter off the insoluble residue, wash it about 15 times with dilute sulphuric acid.

The insoluble residue is then washed off into the original beaker and held for further treatment to be described later. It will contain much or little of the Cr and V, depending on the total percentage of carbides present. The filter paper may still contain a little V and Cr in its pores. Ash it in a porcelain crucible; dissolve it in a few drops of conc. HCl with heat; fume with 5 cc. 1:1 H_2SO_4 to remove HCl. Add it to A.

Dilute the filtrate from the insoluble carbides at once to about 200 cc., and add 1:1 ammonia slowly with constant stirring till a black precipitate forms. At this stage, add drop by drop about 2 cc. of ammonia in excess to assure a complete precipitation of all the chromium and vanadium with very little iron.

Filter at once and redissolve in 50 cc. 1:3 H_2SO_4 . Wash paper 25 times with dilute sulphuric acid wash. Pour filtrate and washings into the original beaker containing the insoluble residue (vol. at this point

should not be more than 100 cc.). Heat beaker for a while and add 40 cc. of 1:20 HNO_3 to oxidize all carbides (A).

Continue to heat until any tungsten carbide present is yellow. By this time vanadium and chromium will be in solution, or if no tungsten is present, heat until all red fumes are gone and the residue is white and floating. Boil a few minutes and then add permanganate from a pipette a little at a time until a brown precipitate of manganese oxide forms that does not dissolve after 20 min. boiling. The boiling with permanganate brings the chromium and vanadium to their highest stage of oxidation.

Filter off the excess of manganese oxide together with some silicon and tungsten, if any is present. Use a heavy suction bottle and a porous crucible (zirconia crucible is preferred).

Wash the residue in the crucible about 15 times with water only. Transfer to clean beaker, volume about 300 cc. Finish as usual for chromium and vanadium with ferriyanide as an internal indicator. See the writer's method, "Rapid Methods for the Chemical Analysis of Special Steels, etc.," second edition, pages 7, 8, 9, 10, 11, 12 and 35-42.

The advantage of the method of course is to remove the bulk of iron, thus enabling the operator to take larger weights of sample. In this way a steel containing 0.01 to 0.02 per cent Cr or V, or both, can be analyzed with just as much accuracy as one containing 1 or 2 per cent Cr and 0.25 per cent V, or higher.

TABLE SHOWING RESULTS OBTAINED BY METHOD ON KNOWN STEELS

Steel Taken, Grams	Chromium Added, Per Cent	Results Found, Per Cent	Vanadium Added, Per Cent	Results Found, Per Cent	Blank, cc.
5	3.070	3.000	0.043	0.056	1.6
10	0.274	0.278	0.040	0.030	1.5
9	0.545	0.550	0.024	0.020	1.5
10	None	None	0.115	0.112	0.6
10	None	None	0.076	0.076	0.6
Cr-V steel 2 g.	3.630	3.61	0.830	0.820	...
Cr-V steel 5 g.	1.060	1.08	0.254	0.244	...
Cr-V steel 5 g.	0.545	0.55	0.024	0.033	...
Cr-V steel 5 g.	1.030	1.01	0.220	0.237	...
U. S. No. 30 std., 3 g.	1.370	1.37	0.215	0.220	...
Cr-V steel 5 g.	1.060	1.05	0.228	0.228	...
24 Cr-V steel 5 g.	1.060	1.03	0.140	0.142	...
Steel 2 g.	None	None	1.913	1.879	0.3
Cr-V steel 2 g.	2.750	2.72	3.190	3.230	...

Much credit is due to Mr. Max Engleman for the painstaking way in which the analyses were carried through to get the analytical proof given in the foregoing tables of recoveries for uranium, zirconium, aluminium, chromium and vanadium.

COPPER, NICKEL, TITANIUM AND TANTALUM

In all probability, the same scheme of precipitating the element away from the bulk of the ferrous iron by ammonia will answer equally well for the determination of large and small percentages of titanium and tantalum. Perhaps also for small amounts of copper and nickel. The author will make this a subject for later publication.

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Pittsburgh, Pa.

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Temperature Observations on Heating, Quenching and Drawing of a Large Steel Forging

Determination of the Rate of Heating and Cooling of Large Masses of Steel—Arrangement of Thermocouples—Furnace and Forging Temperature Curves—Inverse Rate and Temperature-Seconds Curves

By O. A. KNIGHT* AND F. F. HANSEN†

THE following experiment was conducted by the authors at the heat-treating plant of the Watertown Arsenal. An experiment closely approximating this one was carried out in the summer and fall of 1914 at the plant of the Midvale Steel Co. and is given in a report by Mr. M. E. Leeds in the *Proceedings* of the American Society for Testing Materials, Vol. XV, Part II, 1915, page 5. The results recorded in the present paper are, however, not in agreement with those reported by Mr. Leeds as regards the relation of temperature of forging to temperature of furnace.

The object of this investigation was to obtain accurate data on the rate of heating and cooling of large masses of steel. In addition to this it was desired to determine the relation existing between the temperature of the furnace and the temperature of the mass of steel on heating to, and holding at, the maximum temperature employed. The rate of cooling when the forging was oil quenched was also determined and the inverse rate cooling curve plotted.

The inverse rate cooling curve, shown in this report, illustrates clearly that even with large masses of steel the critical transformation point is well defined. The heating curves show that the forging never attained the temperature of the furnace, but that on the contrary even though the temperature of the furnace was held constant for over an hour the temperature of the forging remained likewise constant, but was several degrees lower.

A study of the heating curves indicates that for any given temperature of furnace the maximum temperature to which the interior of the mass of steel will rise is soon established. The curves indicate that the higher the temperature the more nearly does the temperature of the steel coincide with that of the furnace. It is also shown that a large piece such as used in this experiment does not lose an appreciable amount of heat during a short interval of time in the air which must occur during the transfer of the piece from the furnace to the quenching bath.

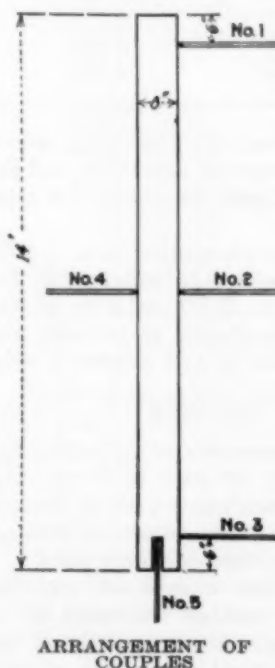
The rate of cooling of a large piece when quenched in oil is far from being as rapid as is generally supposed. Thirteen minutes was required to cool the forging in question from 800 deg. to 300 deg. C. and 23 minutes to cool from 800 deg. to 200 deg. C.

The observations in this experiment were made on a forging 14 ft. in length by 8 in. in diameter. The forging was heated in a vertical oil-fired furnace, being handled and held in proper position by an overhead crane. Five base metal thermocouples were used in

making the temperature measurements. All were carefully calibrated against a platinum standard before being used. One was placed near the top, two near the middle and one near the bottom of the forging with the hot junction of the couple in each case approximately 2 in. from the forging. These couples were protected by being properly insulated and enclosed in iron pipe. The fifth couple employed was inserted in the center of the lower end of the forging to a depth of 6 inches. The arrangement of the couples is shown in the accompanying sketch.

The long couple inserted in the lower end and used in determining the temperature of the forging was carefully insulated and after the hot junction was inserted to the proper depth

it was carefully padded with asbestos felt and covered with sodium silicate (water glass) to exclude all furnace gases or oil which might otherwise influence the results. All of the couples were of the base metal type made from iron and constantin wire. The four used in determining the furnace temperature, i.e., placed near the surface of the forging, were connected to a Leeds & Northrup six-point recording potentiometer. The one inserted in the forging was connected to a portable potentiometer of the same make. With this arrangement for determining temperatures the data herein recorded may be taken to be accurate at least to a limit



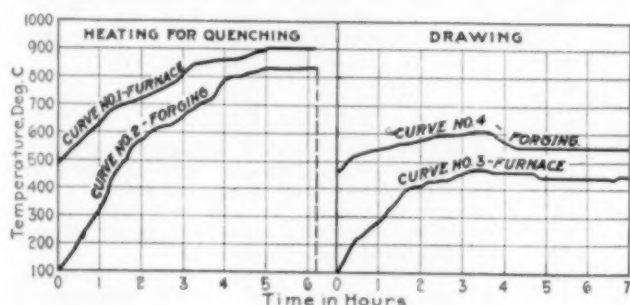
of 10 deg. C., since both the instruments and couples were carefully calibrated immediately before use.

The forging was gradually heated to 835 deg. C. and held approximately one hour at that temperature before quenching. The total time of heating was a little over six hours. After holding the forging at the temperature of 835 deg. C. for the desired time it was removed from the furnace and quenched in cottonseed oil. The total time expiring from the time the forging was withdrawn from the furnace to the time when it was quenched was 10 minutes. During this time in the air the piece cooled 8 deg. C. as measured by the couple inserted in the end.

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A study of the curves submitted with this report will bring out many points of interest. First, it will be noted at the beginning of operations, when the temperature of the furnace, as indicated by the average of the four couples near the surface of the forging, all of whose readings closely agreed, was 480 deg. C., that of the forging was only 100 deg. C. Curves No. 1 and No. 2 of the furnace and forging respectively are plotted

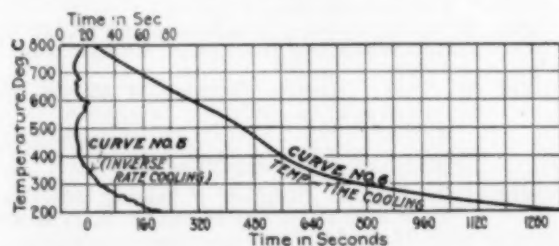


time as abscissa and temperature as ordinate. The temperature readings were taken every 10 minutes.

It will be noted that the temperature of the furnace was at no time attained by the forging, and the lower the temperature the greater the difference in temperature of furnace and forging. It will be further observed that holding the furnace temperature constant at 900 deg. C. for slightly over an hour imparted a uniform temperature of 835 deg. C. to the forging.

This is not at all in agreement with the data recorded by Mr. Leeds in his report previously referred to. The greatest difference he recorded between the temperature of the furnace and the center of the 12-in. specimen is shown in curve C, Fig. 5, of his report and is approximately 40 deg. F. at the end of a total heating of 7 hours.

Curves No. 3 and No. 4 show a similar relation between the temperature of the furnace and the temperature of the forging during the drawing operation. In the report by Mr. Leeds at the temperature of 1000 deg. F. (538 deg. C.) the temperature of forging



differs from that of the furnace by only a few degrees F. From curves No. 3 and No. 4 of the present report it is seen that while the temperature of the furnace is maintained constant at about 550 deg. C., the temperature of the forging is practically 100 deg. C. lower; thus a considerable difference exists in the two records taken. The curves submitted in the present report are plotted exactly from the data obtained without smoothing out any irregularities whatever.

Inverse rate and temperature-time curves plotted from the data obtained on cooling the forging in oil are also shown. It is to be noted that the rate of cooling is by no means as fast as commonly supposed to result from oil quenching. The transformation at the

critical point on heating was so distinct that it could easily be detected while observing the electromotive force indicated by the couple. The temperature actually remained constant a short time at this point, which was 702 deg. C. The critical point on cooling is also quite plain in the inverse rate cooling curve. It occurred at 590 deg. C. as shown.

It is the hope of the authors of this brief paper to present at some future date more detailed data upon this subject, with the time of holding at the maximum temperature materially lengthened.

Metallic Coatings for Rust-Proofing Iron and Steel—III. Bibliography

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THE bibliography of the general subject of corrosion is extremely voluminous; probably more has been written on this subject than on any other phase of physical metallurgy. Many of the articles merely reiterate statements which have previously been published. Below is given a list of the most helpful contributions to the discussion of different phases of the subject as related to the rust-proofing of iron and steel by means of metallic coatings. The references to the literature throughout the text have been made by referring to the proper number in the first column:

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Imports and Exports

The Bureau of Foreign and Domestic Commerce of the Department of Commerce reports for March, 1919:

DOMESTIC EXPORTS OF TIN PLATE, TERNEPLATE AND TAGGERS
TIN FROM THE UNITED STATES TO ALL COUNTRIES

Countries	Lb.	Value	Countries	Lb.	Value
Denmark.....	1,036,300	\$135,662	Argentina.....	8,497,017	752,759
France.....	61,227	4,985	Bolivia.....	167,134	18,744
Greece.....	72,105	9,479	Brasil.....	1,370,378	128,111
Norway.....	4,810,582	423,439	Chile.....	699,884	39,257
Spain.....	121,400	12,650	Colombia.....	1,002	102
Sweden.....	36,000	5,572	British Guiana.....	38,620	3,480
Switzerland.....	266,560	20,167	Paraguay.....	155,119	12,417
Canada.....	7,029,649	536,288	Peru.....	43,961	3,376
Costa Rica.....	10,904	989	Uruguay.....	6,866,302	553,164
Guatemala.....	13,726	1,710	Venezuela.....	9,500	1,033
Panama.....	4,080	1,585	China.....	2,750,281	226,103
Mexico.....	1,350,435	121,693	Japanese China.....	75,416	9,450
Jamaica.....	37,481	3,319	British India.....	1,436,910	108,056
Trinidad and Tobago.....	4,142	425	Straits Settle- ments.....	651,650	49,005
Other British West Indies (except Bar- bados).....	900	165	Dutch East In- dies.....	631,342	74,511
Cuba.....	144,064	11,774	Hongkong.....	479,584	44,549
Virgin Islands of U. S.....	38	5	Japan.....	16,260,539	1,656,300
French West In- dies.....	22,500	2,350	Australia.....	65	12
Haiti.....	500	48	British South Af- rica.....	1,000	225
			Egypt.....	347,680	24,882
			Total.....	55,305,977	\$4,997,846

IMPORTS OF TIN BARS, BLOCKS, PIGS, OR GRAIN OR GRANULATED, INTO THE UNITED STATES FROM COUNTRIES AND DISTRICTS—TOTAL IMPORTS OF TIN ORE

	Tons	Value
Tin ore.....	1,066	\$653,165

TIN BARS, BLOCKS, PIGS, GRAIN OR GRANULATED

Countries	Lb.	Value	Districts	Lb.	Value
Canada.....	282,318	\$186,457	Pittsburgh.....	450,400	345,010
Straits Settlements.....			Maryland.....	56,092	36,361
7,930,972	4,985,611		San Francisco.....	3,153,263	1,847,098
Australia.....	71,680	45,395	Washington.....	2,181,714	1,384,101
			Dakota.....	224,167	144,250
Total.....	8,284,970	\$5,217,463	Wisconsin.....	112,000	76,882
			Chicago.....	1,379,069	911,677
Districts	Lb.	Value			
New York.....	616,083	\$399,241	Total.....	8,284,970	\$5,217,463
Philadelphia.....	112,182	72,843			

U. S. IMPORTS (TOTALS) OF GLYCERINE, AND EXPORTS BY COUNTRIES

Imports		Exports		
Lb.	Value	Countries	Lb.	Value
Glycerine, crude.....		Dominican Republic	374	136
		Argentina.....	53,720	14,977
		Bolivia.....	250	64
		Brazil.....	15,418	4,490
		Chile.....	5,740	1,385
		Colombia.....	2,286	1,072
		Ecuador.....	250	95
		French Guiana.....	30	10
Iceland and Faroe Islands.....	200	Peru.....	1,660	741
Norway.....	145,760	Uruguay.....	112	53
British Honduras.....	10	Venezuela.....	3,371	786
Canada.....	1,310	China.....	20,700	7,652
Guatemala.....	738	British India.....	12,300	3,244
Honduras.....	102	Dutch East Indies..	3,800	2,745
Nicaragua.....	88	Hongkong.....	500	220
Panama.....	20	Siam.....	104,867	25,268
Salvador.....	200	Japan.....	52	41
Mexico.....	10,410	Other Br. Oceania (except New Zealand)	10	4
Barbados.....	135	Philippine Islands..	65	22
Other British West Indies (except Jamaica, Trinidad and Tobago).....	20	British South Africa	6,245	2,127
Cuba.....	15,900			
Dutch West Indies.....	252			
Haiti.....	50			

U. S. IMPORTS AND EXPORTS OF COPPER (TOTALS ONLY)

	Imports		
	Tons	Lb.	Value
Ore.....	14,772	4,475,752	\$894,342
Concentrates.....	8,700	2,229,506	396,395
Matte and regulus, coarse metal and cement	5,874	3,441,721	682,827
Manufactures of unrefined, black, blister			
and converter copper in bars, pigs or			
other forms.....		49,564,536	11,645,397
Refined copper in bars, plates, rods or other			
forms.....		1,678,919	367,857
Old and clippings for remanufacture.....		400,240	52,540
Composition metal, copper chief value.....		10,233	1,500
	Exports		
Ore.....	29	1,600	300
Concentrates, matte and regulus.....			
Pigs, ingots, plates, wire, etc., unrefined			
black, blister and converter copper.....		269,343	90,100
Refined copper in ingots, bars or other			
forms.....		13,088,819	2,937,035
Composition metal, copper chief value.....		85,015	26,532
Old and scrap.....		219,036	34,424
Pipes and tubes.....		665,219	246,686
Plates and sheets.....		853,543	321,236
Wire, except insulated.....		12,039,554	3,423,090
All other manufactures of.....			709,093

IMPORTS INTO THE U. S. OF PLATINUM, IRIIDIUM, OSMIUM, PALLADIUM, ETC., AND NATIVE COMBINATIONS THEREOF WITH PLATINUM, ETC.

[illegible]

U. S. EXPORTS OF CAUSTIC SODA AND SODA ASH, BY COUNTRIES

Countries	Caustic Soda		Soda Ash	
	Lb.	Value	Lb.	Value
Denmark.....	55,550	\$2,750		
France.....	4,033	950		
Greece.....	241,600	10,214		
Italy.....	112,000	14,318		
Norway.....	699,571	53,171	22,400	\$1,008
Sweden.....	474,663	17,390	1,008,220	51,633
Switzerland.....	73	29		
England.....	380	50		
British Honduras.....	1,545	76		
Canada.....	502,050	20,038	3,131,787	69,220
Costa Rica.....	33,750	1,850	2,400	84
Guatemala.....	6,130	363	200	25
Honduras.....	25,580	924		
Nicaragua.....	305	42	1,112	32
Panama.....	2,179	80	5,880	182
Salvador.....	5,300	270		
Mexico.....	1,325,438	62,146	347,719	7,541
Newfoundland and Labrador...	1,513	76	2,415	89
Jamaica.....			300	5
Other British West Indies (ex- cept Barbados, Trinidad and Tobago).....	2,600	295	750	15
Cuba.....	495,505	16,264	96,730	1,748
Dominican Republic.....	26,075	861		
Argentina.....	510,826	21,584	102,880	1,498
Brazil.....	595,469	36,426	374,953	18,169
Chile.....	102,930	4,522	30,000	570
Colombia.....	75,509	3,164	18,130	910
Ecuador.....	4,200	147		
Peru.....	74,895	3,460	27,900	614
Uruguay.....	175,000	9,375		
Venezuela.....	201,840	9,190	3,876	137
China.....	1,129,136	55,506	252,100	12,149
Japanese China.....	450	80		
Chosen.....	450	80		
British India.....	76,000	3,306		
Dutch East Indies.....	1,302,582	86,833	358,390	15,833
Hongkong.....	218,325	13,238		
Japan.....	3,085,109	151,645	2,707,135	84,946
Russia in Asia.....	114,090	9,180		
Australia.....	34,160	1,066	4,480	145
Philippine Islands.....	164,162	9,554		
British West Africa.....	325	8		
Portuguese Africa.....	228	30		
Total.....	11,881,462	\$620,551	8,499,759	\$266,555

DOMESTIC EXPORTS OF ZINC SPELTER AND OF ZINC ROLLED IN SHEETS, STRIPS, ETC., FROM THE U. S. TO ALL COUNTRIES

Countries	Zinc Spelter Cast in Pigs, Slabs, Etc. Produced from Domestic Ore		Zinc Spelter, Cast in Slabs, Pigs, Etc. Produced from Foreign Ore		Zinc Rolled in Sheets, Strips, Etc.	
	Lb.	Value	Lb.	Value	Lb.	Value
Belgium.....	537,600	\$40,320	.....	.....	.....	.....
Denmark.....	6,724	650	.....	.....	10,691	\$2,799
France.....	2,657,112	266,323	.....	.....	.....	.....
Italy.....	3,351,896	226,253	560,040	\$67,205	3,232,311	440,735
Norway.....	145,635	13,250	.....	.....	29,150	4,642
Spain.....	55,400	4,200	.....	.....	.....	.....
England.....	6,984,049	573,400	1,080,715	93,601	273,992	37,226
Scotland.....	.....	.....	46,000	3,379	119,845	21,188
Canada.....	513,628	37,773	80,022	3,081	119,650	15,773
Costa Rica.....	.....	.....	.....	.....	638	119
Nicaragua.....	.....	.....	.....	.....	436	82
Salvador.....	.....	.....	.....	.....	154	31
Mexico.....	.....	.....	.....	.....	113,140	13,959
French West In- dies.....	.....	.....	.....	.....	5,415	866
Argentina.....	.....	.....	.....	.....	90,187	16,056
Brazil.....	.....	.....	.....	.....	118,514	22,558
Chile.....	125	8	.....	.....	3,353	858
Colombia.....	.....	.....	.....	.....	6,713	1,052
Uruguay.....	.....	.....	.....	.....	2,700	650
Venezuela.....	.....	.....	.....	.....	2,500	427
China.....	.....	.....	.....	.....	32,119	5,432
British India.....	.....	.....	.....	.....	3,860	826
Dutch East Indies	9,000	900	.....	.....	72,713	11,502
Japan.....	112,000	9,862	.....	.....	76,813	13,519
Siam.....	.....	.....	.....	.....	41,122	7,284
Australia.....	.....	.....	.....	.....	13,108	3,238
Philippine Islands	.....	.....	.....	.....	2,284	341
British West Afri- ca.....	.....	.....	.....	.....	271	82
British South Afri- ca.....	.....	.....	.....	.....	.....	.....
Total.....	14,373,192	\$1,172,939	1,786,277	\$171,266	5,368,115	\$762,904

Synopsis of Recent Chemical and Metallurgical Literature

Chemically Reactive Alloys.—E. A. ASHCROFT, in a paper recently read before the Faraday Society, described the properties of the binary system magnesium-lead. An alloy containing 15 per cent Mg when exposed to humid atmosphere will oxidize completely in a few hours to a jet-black powder, a mixture of hydrates and lead suboxide. This reaction can be used to remove the last traces of oxygen in a gas mixture or for the manufacture of small amounts of atmospheric nitrogen. Alloys with 35 per cent Mg rapidly decompose water at 150 deg. C. with the formation of metallic oxides and hydrogen, which reaction is very useful in aeronautics, requiring only a steam boiler and a readily transported alloy. The alloys are easily made by melting the primary metals under cover, or more preferably, by the electrolysis of fused anhydrous $MgCl_2$ over a cathode of molten lead.

Calcium-lead alloys act somewhat similarly, but not so rapidly. Zinc-magnesium in similar proportions, on the other hand, appears to be less readily oxidized than either component alone.

Corrosion of Condenser Tubes.—The fourth report of the Corrosion Committee of the Institute of Metals was presented in summary at the April, 1919, meeting, by G. D. BENGOUGH and O. F. HUDSON. Corrosion of zinc in distilled and sea water is regarded by the authors as being a process of chemical oxidation rather than electrochemical displacement, wherein H_2CO_3 locally dissolves the protective scale of oxide or basic carbonate existing on normal metal, baring a true metallic surface where a peculiar oxide—probably containing zinc peroxide—forms, which is slightly soluble, but is later

precipitated as the ordinary hydroxide and carbonate, forming a protective coat.

Corrosion of pure copper is also chemical. A lower oxide (Cu_2O or Cu_3O_2) is formed on immersion which is protective but is slowly peroxidized into cupric hydroxide or basic carbonate. This in turn flakes off due to the formation of underlying bulky products: porous and amorphous oxides, slightly soluble. Pronounced local action does not occur.

When coupling electrodes of different metals the corrosion was often at variance to electrode potential lists, and the authors think that the effects of electrolytic corrosion have been over-emphasized, since sufficiently good contact is difficult to get. For instance, a metal may be oxidized and go into solution in spite of the fact that it is continuously cathodic.

Severe pitting of aluminium and some light alloys at the water line is shown to be due to the presence of strongly acid salt. Brass (70:30) corrodes by solution of some zinc and a little copper in H_2CO_3 , the remainder of both adhering as an oxide scale, becoming further oxidized locally and covered with thick porous deposits of the products of attack. Attack is accompanied by redeposition of copper, and is uniform in nature rather than a local dezincification. Pitting is due to accumulation of the products of corrosion, especially in sea-water.

A table (Table I) is presented of condenser tube troubles and remedies. In order that a tube may have a minimum life of 20 years, only clear water leaving no sediments should enter, this water to be neutral and free from gases in suspension or abnormal amounts in solution, not more than 35 deg. C. in temperature at the hottest region. Condenser water should travel about 5 or 6 ft. per second and the steam should be properly distributed. In practice quick failures are due to the fact that the normal slow roughening by chemical oxidation is locally accelerated by factors independent of the tube.

TABLE I—CAUSES OF CONDENSER TUBE AND FERRULE CORROSION. (WATER SIDE ONLY CONSIDERED)

Cause	How Produced	Nature of Action	How to Be Remedied
A. Foreign bodies carried in and accumulation of products.	A1. By ferric hydrate flakes from water ends. A2. By ashes, clinkers, etc. A3. By sludge of sorts in water supply.	Complete corrosion of the oxide disintegration type, causing local action.	A1. Paint the pipe line and water ends. Increase water speed. A1, A2, and A3. If worth while trap the water supply or pass it through a screen. In some cases increase water speed.
B. Acid or other bad or variable water supply.	B1. Some river supplies, e.g. Tyne. B2. Some canal supplies, e.g. ship canal. B3. Some well supplies. B4. Some estuarine supplies. B5. Some cooling tower arrangements.	Complete corrosion and rapid general thinning. Sometimes slight uniform desincification.	Keep water supply slightly alkaline. Use special tubes adapted to the special conditions.
C. Temperature in condenser too high.	C1. Hot inlet water, e.g. tropical. C2. Slow water speed. C3. Partial blocking of tubes.	C1. Desincification. C2. Desincification. C3. See A3.	C1 and C2. Use special tubes. C2. Increase speed. C3. See A3.
D. Undue aeration.	D1. Errors in pump and pipe line arrangements. D2. Eddies near inlet causing water-line effect.	D1. Complete corrosion of oxide disintegration type. D2. Complete corrosion of pitted areas.	D1. Remedy air leaks, etc. D2. Special ferrules. Possibly increasing speed of water with modified design of water end.
E. Unsuitable composition of tube.	E1. Zinc or impurities in too great amount. E2. Surface of tube not sufficiently copper rich.	E1. Varies. E2. Desincification.	E1. In manufacturing. E2. Probably by attention to details of annealing and pickling during manufacture.
F. Defective packing of tubes.	F1. Leaks caused by perishing of the packing material, especially in acid water. F2. Collapsing of tube.	F1. Varies. F2. Varies.	F1. Use good tape packing. Red lead is sometimes useful to prevent leakage. F2. Do not crush tube when inserting it.
G. Physically bad surface of tube; e.g. bad spills and laminations.	G1. Foreign bodies caught and trapped which would otherwise be swept away.	G1. Complete corrosion and oxide desincification.	G1. During manufacture.
H. Thermo-electric action in condenser.	H. By steam impinging directly on tubes, or being improperly distributed.	H. Desincification.	H1. Only occurs in condensers of old design when steam is not properly distributed.
I. Too slow water speed.	I. Gases given off inside tube and not immediately swept away.	I. Complete corrosion near inlet end.	I. Increase speed of water. Do not use main condenser for auxiliary machinery import.

Relation of Hardness to Tensile Tests.—Results of 114 tests on "smokeless-barrel steel" used in light Browning rapid-fire guns (C, 0.50 to 0.60 per cent; Mn, 1.15 to 1.30; Si, 0.18 to 0.25; P, 0.08 max.; S, 0.06 max.; ultimate 110,000; yield 75,000; reduction 40 per cent, elongation 20 per cent in 2 in.) are graphically tabulated by PROF. W. K. SHEPARD of Sheffield Scientific School in *American Machinist* for Apr. 17, 1919, p. 739. Inspection of the results shows that all specimens attaining the yield point had an ultimate strength of 115,000, while a reduction of 45 per cent would have agreed better with the 20 per cent elongation specification. Scleroscope tests fail to show any indication of low elongation, while the Brinell number between 255 and 269 shows a proper yield point and ductility. While the author does not advocate the replacement of tensile with hardness tests, he points out that inferior material can be easily located with a Brinell machine.

Tungsten in England.—JULIUS L. F. VOGEL, the metallurgist who founded the British tungsten industry, read a paper at the British Science Guild Exhibition on Aug. 30, 1918 (republished in the *Mining Magazine* for Jan., 1919), in which he reviewed the past and present situation of tungsten in England. He noted that Samuel Osborn & Co. of Sheffield made Mushet steel containing 6 to 8 per cent W for many years following its first use in 1857. The process consisted of reducing pure ore in a crucible of blister steel with an excess of carbon. F. W. Taylor's American researches caused an enormous advance in the use of high-speed steel, limited only by the gradual replacement of old machines insufficiently strong to take heavy, rapid cuts. Taylor and White's patents, by the way, were not upheld in England, and the larger production of high-tungsten alloys demanded a very pure alloying element, free from impurities omnipresent in wolfram (hubnerite, ferberite, etc.) such as Sn, Ca, As, S and P. At first a ferrotungsten of from 40 to 60 per cent was made in a crucible by carbon reduction, but the insistent demand for tungsten powder containing 95 per cent W and upward was met exclusively by the Germans, who were able to make 98 per cent metal with less than 0.5 per cent C. Hence grew the German monopoly of the European trade, despite several small-scale attempts in England to make tungsten powder.

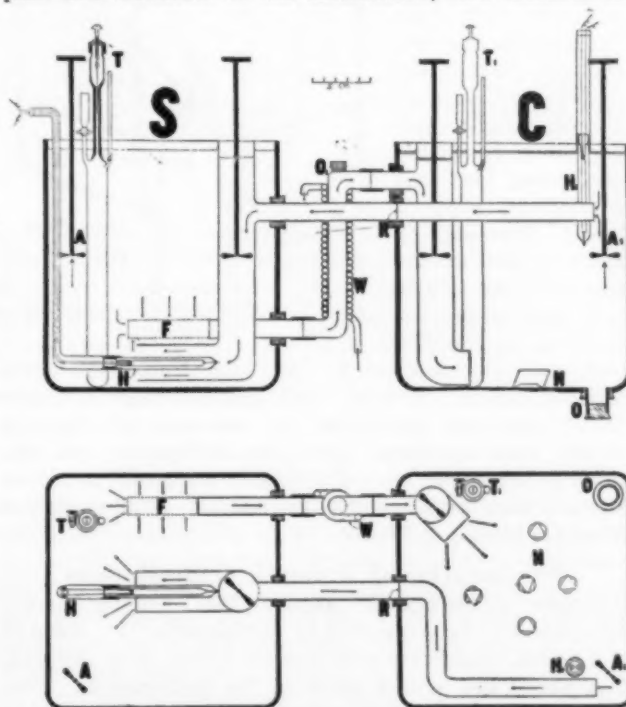
On the declaration of war, England was left with a stock of but four months' normal consumption, and immediate conferences decided upon the stimulation of ore-production and local manufacture of high-grade tungsten powder. At the request of the Indian government a number of substantial Indian merchants took up and explored concessions in the recently opened Burmese districts. These men equipped mines and furnished transportation, resulting in largely increased production, but naturally at high cost. In many cases large sums were spent from which no return is likely.

English firms which collectively used some 80 per cent of the British consumption also immediately formed the High Speed Steel Alloys, Ltd., and by July, 1915, their factory at Widnes was delivering 98.5 per cent metal under the direction of the author. Their plant is substantially built, and is really but an enlarged laboratory. Fine ground ore is mixed with soda and fused, the cake crushed and boiled with water. Tungstate of soda goes into solution, while the insoluble basic oxides are filtered out. Pure tungstic acid (WO_3) is precipitated by HCl, filtered, dried, and reduced to

metallic powder in special furnaces. Finally, the furnace product is washed and dried before packing.

Other companies have also entered this field, such as the Thermo-Electric Co., Blackwells, Continuous Reduction Co., British Thermit Co., Newcastle Alloys Co., Tyneside Alloys, and Albright & Wilson. Three of these use chemical processes similar to that at Widnes, two make ferrotungsten in an electric furnace, and three by aluminothermic methods. English makers of tool steels prefer the tungsten powder for its greater purity, although with pure ores, properly operated thermal processes will make a ferrotungsten which can be successfully employed in making high-speed steel.

Growth of Crystals.—The Feb. 19, 1919, issue of the *Journal* of the Washington Academy of Sciences contains an illustrated description of an apparatus used by J. C. HOSTETTER of the Geophysical Laboratory to form perfect crystals under controlled conditions for the study of strength, linear force of growing crystals, effects of non-uniform pressure on solubility, and effects of foreign substances in solution. While the apparatus has been used to study aqueous solutions, obvious modifications would permit the growth of substances of small solubility or from melts. The apparatus is shown in plan and elevation in the illustration, and consists es-



entially of two thermostats boxed together, the saturator S and the crystallizer C. By means of the thermostat T operating through relays the candle lamp H, S is maintained at a slightly higher temperature than C and is about $\frac{1}{2}$ filled with large or bagged crystals. Saturated solution is drawn through gauze filter F into C, being directed against crystals N, placed on plane glass, and turned over daily. Volunteer crystals may be removed through O.

Perfect crystals require constancy in growth, which demands constant degree of supersaturation, constant temperature, uniform circulation, and a constant number of nuclei. The nuclei should be introduced at the start; they are small, well-formed crystals collected from a warm saturated solution allowed to cool overnight.

Recent Chemical and Metallurgical Patents

Buffer for Schoenherr Furnace.—JENS L. LA COUR, of Christiania, Norway, patents a buffer for nitrogen furnaces with long stable arcs under high gas pressure designed to minimize the effects of variations of gas pressure and velocity. It consists of a boiler (Fig. 1) mounted directly at the top of the tube-furnace *a*. Hot

burned gases rising through *d* are partly cooled in the corrugated tube *c*, thence passing through the smaller tubes are drawn off the bottom of the casing. The steam pressure generated in this buffer-cooler is approximately equal to the gas pressure in the tube furnace, so that the metallic walls are under balanced forces. Such buffers may be placed in series, the first producing but a small decrease in temperature at the top of the flame tube in case the stability of the furnace action demands it. In any case, the buffer tube *c* being in line with the furnace *a* facilitates necessary variations in the end of the arc at *d* and equalizes pressure differences in the reaction chamber *a*. (1,296,194; assigned to Norsk Hydro-Elektrisk Kvaestofaktieselskab, of Christiania, Norway, March 4, 1919.)

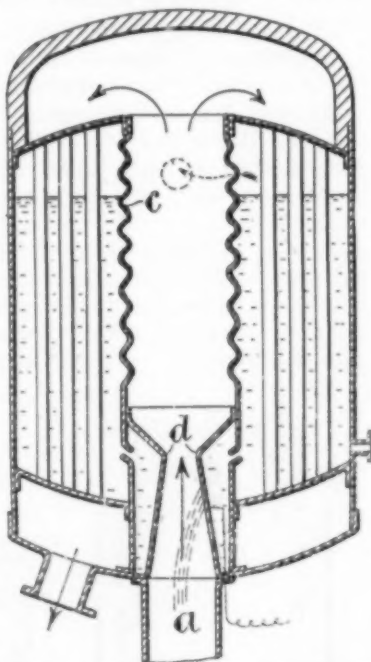


FIG. 1. BUFFER FOR NITROGEN FURNACE

Sulphonation of Aromatic Hydrocarbons

Aromatic Sulphonic Acids¹—The counter-current principle has been applied to sulphonation by AMBLER and GIBBS. Sulphuric acid (sp.gr. 1.84), at a temperature above the boiling point of the hydrocarbon, flows down through a tower containing baffle plates, while vapors of the hydrocarbon are introduced at a point below the center of the tower. The process is continuous and, owing to the rapid removal of the sulphonated product, undesirable secondary transformations are practically eliminated. With toluene, monosulphonic acids are formed at 150 deg. C., while at 240-250 deg. C. the product is mainly toluenedisulphonic acid. (1,300,227 and 1,300,228; Apr. 8, 1919; dedicated to the public.)

Benzene Sulphonic Acids.—Benzene is passed into a still containing hot sulphuric acid (150-180 deg. C.) through a perforated ring below the surface of the acid. Unconverted vapors are condensed and returned to a storage tank. After a time, the speed of the reaction is

greatly diminished, due to the dilution of the acid. When this point is reached (the ratio of free sulphuric acid to water in the mixture being 78 : 22) the system is evacuated by a suitable pump and the elimination of water vapor is facilitated by the stream of benzene vapor. By repeating these operations, a product containing over 90 per cent sulphonic acid and not more than 5 per cent free sulphuric acid may be obtained. This may be converted directly into the sodium salt without the necessity of first preparing the calcium salt. (1,301,360; ANDREW BENDER of Bogota, N. J., Apr. 22, 1919.)

Benzene Disulphonic Acid.—Another method for the production of sulphonic acids relatively free from excess sulphuric acid is described by CHARLES R. DOWNS of Cliffside, N. J. He has found that the mixture obtained by sulphonating hydrocarbons in the presence of excess sulphuric acid may be fractionally distilled under reduced pressure. With an absolute pressure of from one-half to one inch of mercury, water and free sulphuric acid may be removed from benzene disulphonic acid below 260 deg. C. without appreciable decomposition of the latter. Furthermore, during the distillation any monosulphonic acid present is converted into disulphonic acid, so that a very pure product is obtained. For the production of resorcinol this may be neutralized directly with soda ash, etc., and the solution added to the fusion pot without evaporating. (1,301,785; Apr. 22, 1919; assigned to The Barrett Co.)

Purification of Carbazol.—Commercial carbazol usually contains from 10 to 15 per cent of impurities (mainly anthracene), which yield sulphonic acids when treated with sulphuric acid even in the cold, whereas carbazol merely dissolves, provided the temperature is kept below 35 deg. C. The addition of water to the resulting solution precipitates carbazol which is 96 per cent pure and is almost entirely free from anthracene. By a single sublimation it gives substantially pure carbazol. (1,301,796; Apr. 22, 1919; JOHN M. WEISS of New York, assignor to The Barrett Co.)

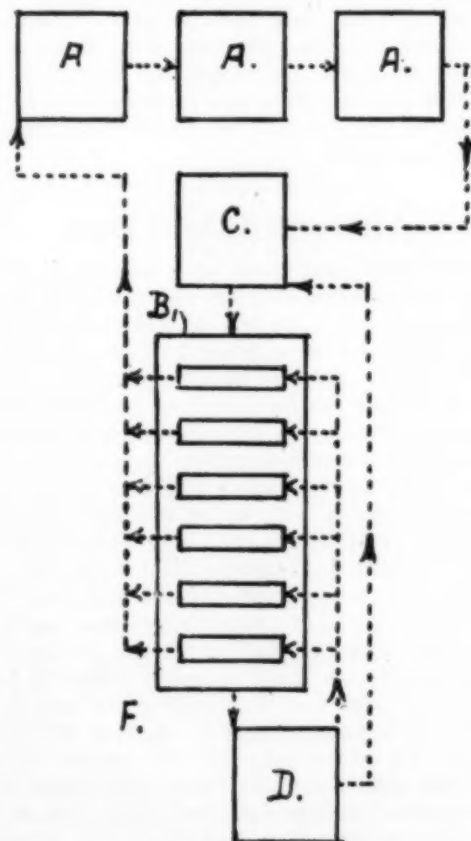
Iron for Precipitating Copper.—WOOLSEY McA. JOHNSON of Hartford, Conn., suggests a method for preparing an efficient precipitation agent for the copper-bearing solutions in leaching processes. He transfers super-heated copper blast-furnace slag from an electrically heated settler into a long trough-like electric furnace. The reduction of iron oxide from such a slag is ordinarily slow, due to the fact that the surfaces in contact with the reducing agent are not sufficiently extensive to maintain a vigorous reaction. He, therefore, mixes the slag with pulverized coal by means of a number of jets of producer gas. The slag is thus progressively deoxidized as it passes along the long furnace, whose atmosphere at the same time is maintained sufficiently low in CO, that the electrode losses per ton of product will be moderate. As the slag flows toward the exit of this trough furnace and becomes lower in iron oxide, it comes in contact with a counter current of reduced iron having a lower and lower content of carbon and silicon. Thus metal quite low in these two elements may be tapped from the head end of the trough furnace, when it can be granulated or cast into such shapes as are desirable for use as a precipitating agent. The reduced iron oxide in the slag is replaced by hot quicklime, together with some fluorspar. (1,300,410; Apr. 15, 1919.)

¹CHEM. & MET. ENG., Mar. 15, 1919, p. 282.

English Patents

Concentrating Ores.—In an agitation froth process for the preferential separation of one metalliferous mineral from another in a mixture containing them, for example a mixed sulphide ore, the agents employed are a soluble soap and sodium silicate in such proportions that a froth rich in one of the minerals is first obtained. After the froth has been separated the liquor may be diluted and re-agitated or aerated for the production of froth rich in another mineral. The ore is preferably treated in a freshly ground condition. (English Patent No. 121,303. E. EDSEY, S. TUCKER and MINERALS SEPARATION, LTD., London, Eng., Feb. 5, 1919.)

Obtaining Metals Electrolytically With Circulating Electrolytes.—Granular Cu-Ni, Cu-Zn, or like alloys, obtained for instance by roasting and reducing matte, are treated with sulphuric acid, or other acid solution, until the acid is neutralized, and the solution is further treated with the same material to cement out the copper and produce a solution of nickel, zinc or the like for electrolysis. Mattes containing the two metals may be substituted for the alloy in the neutralizing



process. Air is introduced with the acid. From towers A, in which this treatment takes place, as shown in the illustration, the solution is run to a tank C, and thence to the cathode compartments of one or more electrolytic vats B. The solution is then conveyed to a tank D, whence most of it is returned to the supply tank C. The rest of this solution from the tank D is passed through the anode compartment F, the acid thus obtained being returned to the towers A. When two or more electrolytic vats are employed, the cathode compartments and the anode compartments may respectively be connected in series as regards liquid flow.

Cathodes of iron and anodes of magnetite or hard lead may be used. The current density is 10 to 15 amp. per sq.ft. (English Patent No. 121,591. G. HAYLUND, Christiania, Norway. Not yet accepted. Feb. 12, 1919.)

Production of Ammonium Perchlorate and Sodium Bicarbonate.—Ammonium perchlorate is produced by reacting upon ammonium nitrate with sodium perchlorate in the presence of water. The precipitated ammonium perchlorate is separated and the solution of sodium nitrate is treated with ammonium bicarbonate or ammonia and carbon dioxide to cause the precipitation of sodium bicarbonate. The solution of ammonium nitrate after the removal of the bicarbonate is then used for reaction with a further quantity of sodium perchlorate. (English Patent No. 121,727—1918. D. AANENSEN, Christiania, Norway. Not yet accepted. Feb. 19, 1919.)

Acid-Proof Alloys.—Acid-proof alloys of iron and silicon containing not less than 13 to 15 per cent or more than 20 to 21 per cent silicon are made in a substantially pure state, preferably in an electric furnace. Pig iron may be melted with ferrosilicon and the impurities allowed to crystallize out of the molten mass, and a small amount of a flux, such as iron sulphide, may be added. Or iron or steel scrap may be melted with ferrosilicon, iron oxide being added when necessary to remove the carbon. The alloys may be used for making vessels for chemical manufactures and as anodes in electrolytic processes. (English Patent No. 121,730—1918. C. ROSSI, Legnano, Italy. Not yet accepted. Feb. 19, 1919.)

Reduction of Tungsten.—PETER ORANCE of New York City notes the difficulties inherent to properly mixing extraneous substances with tungsten oxides previous to their reduction, either by mechanical stirring of powders, by mixing into a paste, or by distillation of the body-material of a container. He proposes to obviate these by placing the tungsten oxide in a small closed shell capable of rotation, and during rocking of the vessel to blow into the mass heated air containing the addition agent, produced by volatilization from electrodes made of that material, by atomizing a solution, or by injecting a powdered material into the air blast. In this manner an intimate and uniform mixture may be had, which is then ready for molding into ingots prior to reduction, swaging and drawing, after the usual methods. (1,297,000; March 11, 1919.)

Improved Saggers.—F. J. TONE, of Niagara Falls, N. Y., has found that saggers or vats used to contain fine porcelains during firing are denser, stronger, more lasting and have a higher heat conductivity if containing a relatively high per cent of carborundum in addition to the usual clay grog plus plastic clay mixture. However, certain constituents of the clay or furnace gases alter the surface of the carborundum grains, which in turn produce a discoloration of the porcelain-ware contained in the sagger. The inventor finds that the action is confined to the surface of the grains, being limited to a thickness of from 0.0001 to 0.00001 cm., and therefore may be controlled by using relatively coarse carborundum (16 mesh) in moderate quantity—approximately 40 per cent of the mix. (1,296,715; assigned to Carborundum Co., March 11, 1919.)

Centrifugal Agitator and Distributor

BY HENRY E. JACOBY

ONE of the simplest problems with which the manufacturing chemist has to contend, and at the same time one which often causes trouble and gives unsatisfactory results, is that of mechanical agitation. One reason for this is that so many operating men devise some crude homemade affair, putting a belt to it, and consider that all has been done that can be done in the way of getting satisfactory mechanical agitation.

The accompanying diagram shows the salient features of a device designed and patented by C. C. Thomas. One is immediately struck with not only the novelty of the mechanism, but also the basic principle which is applied. In general the device not only produces a mechanical stirring of the liquid or liquids in the containing vessel, the same as with the ordinary form of agitator, but at the same time produces a thorough vertical distribution of the material drawn to the vertex of the revolving liquid by means of a hollow vertical shaft.

The agitator is essentially a hollow tee which is supported by a suitable bridging or the cover of the tank, the upper part *A* being a hollow sleeve through which the vertical agitator shaft *B* passes. To the lower end of the sleeve *A* is attached a rigid bevel gear *C*, which meshes with the revolving gears *D* and *D*₁, the functions of which are to revolve the horizontal sleeve spiral distributors *E* and *E*₁ described below.

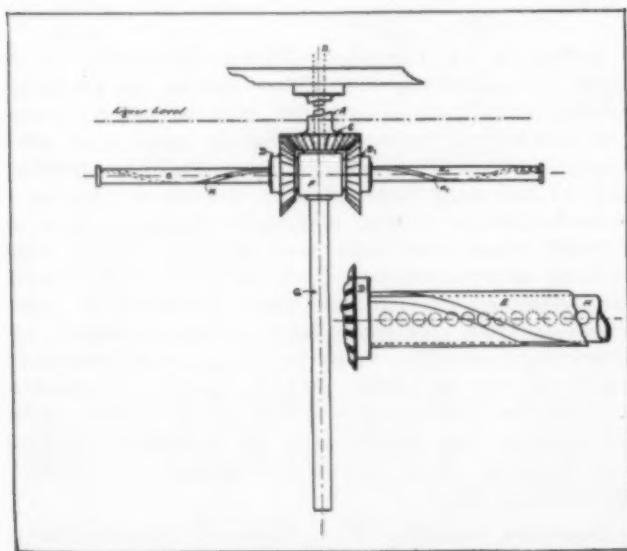
Part *F*, the head of the tee, is rigidly fixed to the solid agitator shaft *B* and revolves therewith. Attached to

The solution so discharged is immediately replaced by liquid through the vertical suction pipe. The result is that even at very low speeds there is a circulation at once set up by liquid being forced from near the bottom of the containing vessel up and out through the revolving arms.

The function of the sleeves *E* and *E*₁ will not be apparent. As the agitator revolves, the bevel gears *D* and *D*₁ meshing with the rigid gear *C*, rotate. The result is that the helical slot in the sleeve will uncover successive discharge holes in the horizontal arms so that the point of the liquor discharge is continually traveling outward. The liquid is discharged at various points in a horizontal plane, and at continually varying distances from the center.

The results obtained by this device are really remarkable; not only is the distribution of the liquid beneficial, but the power required is remarkably small. It can readily be adapted to any existing tank, and will work successfully, not only on liquids of different densities, but will actually manipulate solid particles that are not too large to pass through the row of discharge apertures in the horizontal arms.

The apparatus has been tried out on a small scale for laboratory purposes, and has also been introduced into several manufacturing establishments, where it is giving excellent service. Its simplicity, as well as the excellent results obtained, should recommend it to all who have been on the lookout for an improved method of mechanical agitation.



MECHANICAL AGITATING DEVICE

the lower outlet of the tee is the vertical suction pipe *G*, and into each of the horizontal outlets are screwed the two horizontal arms *H* and *H*₁. These two horizontal arms *H* and *H*₁ are made up of wrought iron pipe perforated with a row of small holes for the liquid discharge. Sleeves *E* and *E*₁, which are rigidly attached to bevel gears *D* and *D*₁, are provided with a helical slot as shown in the diagram. The operation of the agitator is simple: The entire device being submerged in the liquid, the two horizontal arms *H* and *H*₁ are filled with the solution being agitated. As the device is revolved, no matter how slowly, there is sufficient centrifugal force developed in the arms to produce a flow of the solution in the arms toward the periphery.

Airtight Ashpit Door

CONSULTING engineers and architects are often required to draw detailed specifications for ashpit doors, because they have been unable to find a satisfactory standard piece of equipment. Contractors engaged in setting boilers are also often required to construct a steel door on the job because they had been unable to purchase a good door especially designed for the purpose.

The American Steam Conveyor Corporation, Chicago and New York, specializing in all forms of ash disposal, is manufacturing a door which has been produced as the result of careful tests and study, covering all points essential to successful operation and durability. It has been the experience of ash-disposal engineers that an ashpit door should be of ample size to allow easy removal of the ashes from the pit, but should not be unnecessarily large. If too large, it is impossible to keep the door from warping and thus leaking air, and it is also too heavy to be handled easily. A 24 x 36-in. door is ample for the largest pit, and this is the size recommended for ordinary use. Three other sizes of doors are also built of the same general design. These are in size, 18 x 18 in., 22 x 26 in. and 24 x 24 in.

The frame of the door is of cast iron of ample strength for all conditions, with the hinge and locking lugs cast on. The frame is of an angle design and sets well back into the setting. It is easily fastened into the pit wall by four bolts, one in each corner. The bearing surface is carefully machined. The hinge lugs are of ample strength to meet the hard usage to which these doors are subjected in operation.

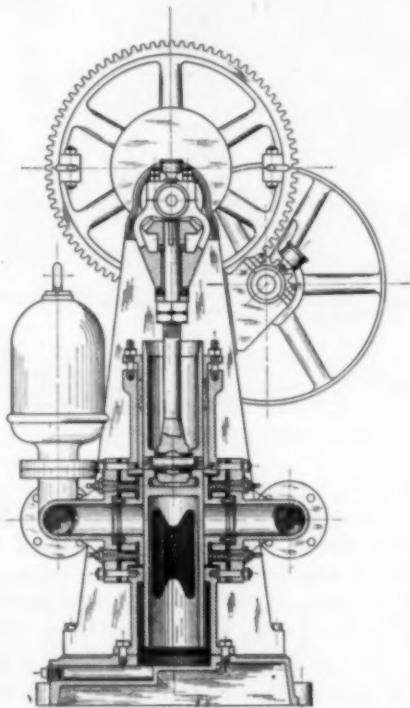
The door itself is of cast iron and is provided with a heavy ventilated cast-iron lining to prevent contact with the hot ashes and consequent warping. The bearing surface is carefully machined to make an airtight joint with the frame.

The hinges are of the floating type and two are provided. The hinge bars are pivoted to the frame and carry the door at the center where it is pivoted to the bars. This gives a perfectly distributed pressure over the door and keeps a tight joint at all points with no possibility of a clinker in the corner of the frame opening breaking or bending the door by a wedge action. It also allows the door to be swung entirely out of the operator's way.

Valveless Pump

THERE is no part of a pump exposed to greater wear than the rubber or other composition used in the valves on the water end. These valves, operating with every stroke of the pump, are not only subject to the continual pound as they open and close, but also have to stand the corrosive action of the fluid pumped. Different valves are required for different service—difference in pressure, difference in temperature of liquid, difference in nature of material pumped.

It is not easy to detect leaky pump valves, on account of their being closed, and a valve, after being in use a short time, may wear and suddenly break, putting a



SECTIONAL VIEW OF PUMP

pump temporarily out of commission at a time when a shutdown for repairs means a considerable loss of time and money.

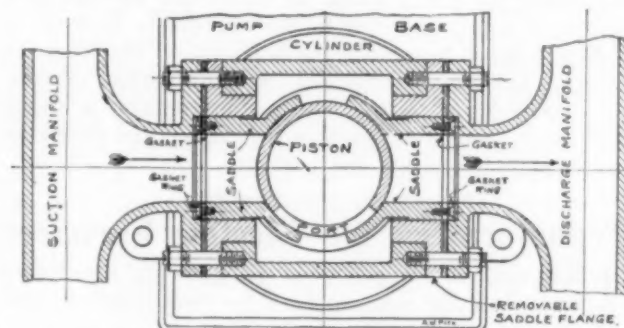
It might be said that the reputation of a pump depends more upon the quality and design of the valves than on any other part of the pump, because pump valves of a poor quality would seem to indicate poor material and workmanship in the pump itself.

Frequent failures of pump valves are often due to the fact that practically one class of pump valves are manufactured and sold for use in all kinds of service. Success under these conditions is practically impossible.

Further, all valves require for successful operation a special tension of valve springs, composition of rubber disc or metal seats. If these are not considered in the

first place, the pump goes wrong, and the best pump is condemned as a failure. Tension of the spring is seldom adjusted evenly on all the valves, and those with the least tension are often to be the only ones that lift, thus defeating the object of multiple valves and greatly lessening the efficiency of the pump.

According to the best authorities, the friction of an ordinary check valve is equivalent to the frictional resistance of from 25 to 125 ft. of clear, straight iron pipe,



SECTIONAL PLAN THROUGH LINE OF SUCTION AND DISCHARGE, SHOWING SADDLES WITH PISTON AT END OF STROKE

varying according to the design, area of opening and tension of springs.

The renewal of valve parts is a continuous item of expense, and cannot be eliminated, unless you do away with valves. Ninety per cent of pump troubles are valve troubles. Ninety per cent of cost of upkeep of a pump is valve renewal cost.

ROTATING PISTON PUMP

A new type of pump having a rotating hollow piston with a port simplifies the valve problem. The Dourte valveless pump, manufactured by the Mine & Smelter Supply Co. of Denver, has an exceptionally free passage for liquid into the cylinder when the suction is opened and a correspondingly free opening into the discharge, making it one of the best conveyors for liquids containing solids such as gravel, sand, sewage, pulp, coky pitches, etc.

The rotary movement of the piston is produced by a pair of miter gears one of which is keyed to the crank pin and the other to the end of the connecting rod. These gears are of equal size and number of teeth, therefore each complete revolution of the crank gives a corresponding revolution and stroke of the piston. With the crank at the extreme top or bottom, the piston is so placed that its port is not engaged with either suction or discharge opening, consequently all entries to the cylinder are closed.

On the upstroke the port in the piston is in connection with the suction opening, the discharge opening being closed or blanked by the wall of the piston. On the downstroke the situation is reversed, the port being in connection with the discharge opening while the suction opening is closed.

Referring to the illustrations, it will be noted that the piston is at the downstroke and the port neutral, being engaged with neither the suction nor discharge openings. As the piston rotates and advances upward spirally, the port engages with the suction or discharge openings, as the case may be.

The pump can be operated with equal efficiency in either direction, as reversing the direction of rotation

automatically reverses the flow of material through the pump. This feature is invaluable where it becomes necessary to clear the suction pipe, or where it is desirable to reverse the direction of flow, as in mixing tanks; thus the necessity of having a complicated arrangement of by-passes or a duplicate piping system is entirely eliminated.

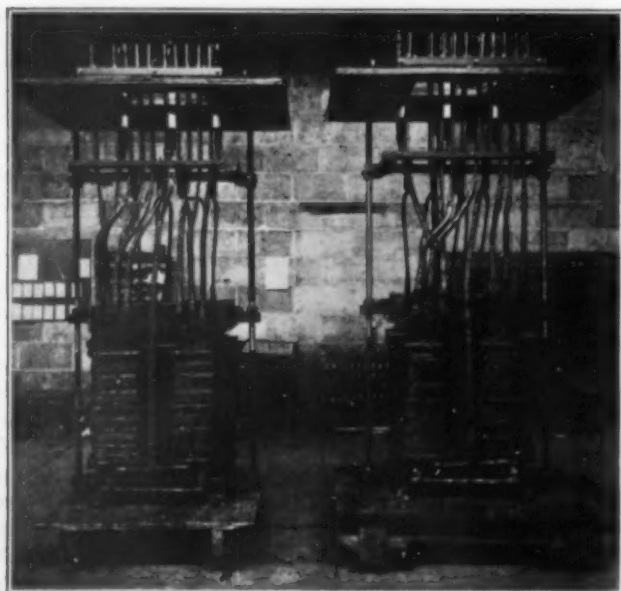
The piston is a hollow casting open at both ends and is divided by a cross web near the center. The upper portion of the piston holds the connecting rod end by a universal joint, and the hollow receptacle here is of sufficient depth to contain the lubricant in which all the working parts are submerged, insuring perfect lubrication. The lower part of the piston contains a single port which alternately engages the suction and discharge openings on the side of the cylinder.

Transformers for Electric Furnaces

THE electric furnace owes its growing acceptance as a desirable medium both for heat-treating steel and melting non-ferrous metals chiefly to the more exacting control that it offers over furnace conditions. To supply an important link in the control equipment of its Baily electric furnaces, the Electric Furnace Co. of Alliance, Ohio, is building special transformers of the type illustrated.

These core type transformers are 400 k.v.a. capacity, and the high tension side, fitted with the usual voltage taps, is wound for 22,000 volts. The low tension side is fitted with ten special voltage taps to meet the particular voltage requirements of the furnace. Each transformer is single phase, and for small furnaces, requiring 100 kw. or less, one transformer is sufficient. Three-phase current is taken care of by two transformers fitted with a Scott connection. By means of the special low tension voltage taps, any desired current input may be delivered to the furnace through the selective oil break switches that are a part of each installation. With furnace current under control, any furnace temperature may be steadily maintained.

The transformers illustrated have just been shipped to the Braeburn Steel Co., Braeburn, Pa., as an accessory of a large 800-kw. continuous recuperative elec-



TRANSFORMER FOR ELECTRIC FURNACE

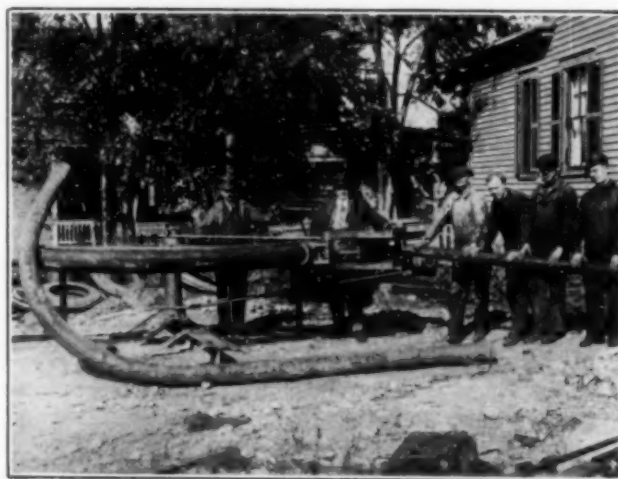
tric furnace that will be used to anneal alloy steel bars and wire. This special alloy requires a slow heating, lengthy soaking at maximum temperature, and cooling at a slow rate for the first 200 to 300 degrees.

This installation is of special interest, for although the usual annealing box covers are not used, scaling is entirely eliminated by this new method of electric annealing.

Pipe Bending Machine

SEVERAL models of portable pipe bending machines designed to handle from 1-1 in., 2-2 in., 11-4 in., and 3-8 in. pipe are manufactured by the American Pipe Bending Machine Co. of Boston. The machines are all of rigid construction, simply designed, and all parts interchangeable. An important feature is that they are all portable and may be knocked down and set up in a few moments.

A brief description of the machine will show its simplicity. The different machines have a central head suitably supported either for bench work, as with the



HERCULES PIPE BENDING MACHINE

Model S, or to be arranged with pipe legs in the larger models, A and B. On this head is mounted the interchangeable former-segments, and swiveled on the head is an arm on which is an adjustably mounted pin. On this pin is journaled a lever, on one end of which is swiveled a shoe of the proper size to fit the pipe to be formed. On the other end of the lever a pipe may be slipped to give sufficient leverage to bend the pipe, and the swinging arm is moved step by step as the pipe is bent, until the final bend is completed.

The large model, or Hercules machine, is operated on a similar principle with improvements to give greatly increased power.

British Import Restrictions

The importation of the following commodities is prohibited except under special license:

Potassium salts, as follows: Bicarbonate, carbonate, chlorate, perchlorate, chloride (muriate), chromate and bichromate, cyanide, ferrocyanide (yellow prussiate), hydrate (caustic), nitrate, permanganate, sulphate, including potassium alums and potash manurial salts and mixtures containing any of these substances. Also saccharine and mixtures containing saccharine and other substances of like nature and use.

Pershing Commends Chemical Warfare Service

AMERICAN EXPEDITIONARY FORCES
Office of the Commander-in-Chief

March 2, 1919.

Col. Edward N. Johnston,
Chief of Chemical Warfare Service,
American E. F., Tours.

My dear Colonel Johnston:—Now that active operations have ceased and many of the personnel of the Chemical Warfare Service are returning to the United States, I desire to express to you and through you to all of your officers and enlisted men my appreciation of the valuable assistance they have rendered to the American Expeditionary Forces.

Upon our entry into the war we were faced with the problem of a new service in the organization of which the experience of our Allies was so new and so limited that there were few precedents to follow. The best brains and experience among our students and teachers of chemistry were called into service, and by rapid establishment of gas schools and the aid of specially trained personnel, all combat troops were instructed in the necessary defensive measures against poisonous gas. The first gas regiment was trained and equipped, and rendered good service in the two American offensives of St. Mihiel and the Meuse-Argonne.

Due to the energetic co-operation of all ranks, much was accomplished in a very short time, for which it gives me great pleasure to extend to you all the thanks of your comrades of the American Expeditionary Forces. Will you convey this especially to Brigadier-General Fries, whose enthusiasm and energy were such great factors in the successful organization and development of the service.

Sincerely yours,
JOHN J. PERSHING.

Water-Resistant Glues

WATER-RESISTANT glues are of two general types, those made from blood albumen and those made from casein. All blood albumen glues are made directly from the raw ingredients at the time the glue is to be used. The manufacturers using these glues make them by their own secret formulas, and there are no published formulas available. Casein glues are made from casein, which is obtained from milk. They can be obtained in the prepared state ready for mixing with water, or they can be made directly from the ingredients at the time the glue is to be used.

The following prepared casein glues are now on the market: Certus glue, Certus Cold Glue Co., 88 Isabelle St., Detroit, Mich.; Napco glue, the Napco Corporation, Indianapolis, Ind.; Casco glue, Casein Mfg. Co., 15 Park Row, New York City, N. Y.; Perkins waterproof glue, Perkins Glue Co., Lansdale, Pa.

Directions for mixing the prepared glues can be obtained from the respective manufacturers or from the Forest Products Laboratory, Madison, Wis.

The water-resistant qualities of casein and blood glues are well demonstrated by the acceptance test imposed on plywood manufactured with these glues for use in aeroplanes. Samples of the plywood are boiled in water for 8 hours or soaked in cold water for 10 days. An

acceptable product will show no separation of the plies under such treatment.

The shearing strength of casein and blood glues in plywood for aeroplane use is required to be at least 150 lb. per sq.in. Most of the plywood tested at the Forest Products Laboratory showed values considerably higher than this minimum requirement. In general, veneer panels glued with blood glue show higher average strength under the varying conditions than those glued with casein glues. It seems possible, however, that casein glues will in time be developed which will be the equal of blood albumen glues in this respect.

Both casein and blood glues are materially weaker wet than dry. Casein glues tested wet commonly have 20 to 40 per cent of their dry plywood shear strength, and blood glues 50 to 75 per cent. When plywood using these glues is redried after being soaked, however, the original strength of the glue is very largely recovered.

Blood glues are not at present commonly used for gluing anything thicker than veneer. Casein glues are used for gluing all thicknesses. Casein glue test joints, using blocks of maple with the grain running in the same direction, commonly have a shearing strength of 2000 to 2500 lb. per sq.in.

Blood albumen glue joints must be made with a "hot press" (having hollow plates heated with steam); a few minutes pressure is sufficient. Casein glue requires only an ordinary press, such as is used, with or without retaining clamps, for animal and vegetable glues.

The spreading equipment used for vegetable glues is suitable for both casein and blood albumen glues.

A mixer similar to the cake dough mixer used by bakers, consisting of a can in which a paddle revolves at high speed, is suitable for mixing casein glues. Blood albumen glues are mixed in different ways according to the requirements of their secret formulas.

Book Reviews

ELECTRO-ANALYSIS. By Edgar F. Smith. Sixth edition, revised, enlarged, 47 illustrations, xiii + 344 pages, octavo. Philadelphia: P. Blakiston's Son & Co.

Analytical chemists and electrochemists in general owe Dr. Smith sincere appreciation of this careful revision of his indispensable book. Originally valuable because of containing the author's first-hand account of his contributions to this subject, the successive editions have grown, by careful condensation of the literature of the art, until it is a nearly complete handbook. Not only is the analytical chemist helped along, but the electroplater, the metal refiner, the electrometallurgist extracting metals from solutions, the electrochemist seeking new ways of coloring metals or of producing metallic compounds electrolytically, and yet other workers in electrolysis, can all find aid and comfort and generous assistance in studying its pages. The separation of the alkali metals in an improved "double cup" apparatus is an important item of novelty in this edition.

J. W. RICHARDS.

THE HYDROGENATION OF OILS, CATALYSIS, GENERATION OF HYDROGEN AND OXYGEN. By Carleton Ellis, S.B. Second Edition, thoroughly revised and enlarged, 767 pages, 240 illustrations. New York: D. Van Nostrand & Co.

The chemical and legal professions, at least those among them interested in the above subject, owe Carleton Ellis a debt of gratitude for his painstaking work in bringing together so many facts pertaining to the art of hydrogenation. He has succeeded remarkably well in giving the his-

tory of the subject from its beginning down to date, with descriptions of the very many processes described in patent and other literature, with full references, which makes the book exceedingly valuable to those interested in the patent side of the subject, while the very full accounts of the important litigations which have taken place add greatly to the interest from a legal standpoint.

The chapters on catalyzers are full of interest and present very fully in a compact form most all that has been written on the subject. The chapters on the uses of hydrogenated oils contain much valuable information, giving among other things a considerable insight into the lard-compound industry. A very useful chapter is the one on analytical constants, which presents in a compact form most everything which we have seen published. Those engaged in work on petroleum oils will find the chapter devoted to that subject very useful. The portion of the book describing the manufacture of hydrogen, covering 165 pages, would make a complete reference book by itself. The book taken as a whole is one which chemists and others connected with fat industries can hardly afford to be without.

DAVID WESSON.

COMMERCIAL OILS, Vegetable and Animal, With Special Reference to Oriental Oils. By *J. F. Laucks*. New York: John Wiley & Sons. 138 pages, inc. index.

This book, as stated in the preface, "is intended primarily for the non-technical man in the oil trade. The writer has attempted to give in it the technical data and information required in everyday dealings in the oil trade without mixing in a great mass of more or less scientific matter." The book contains trade rules and specifications wherever they may apply to the oils mentioned, besides giving conservative analytical constants. It is of particular value at this time, as it gives in a very compact form much information regarding various Oriental oils which are being imported at Pacific Coast points. There are tables showing properties of less common oils, together with comparison tables of hydrometers and thermometers. Last, but not least, is a very comprehensive index. DAVID WESSON.

Personal

DR. R. F. BACON, director of the Mellon Institute, is chairman of the committee of the American Institute of Chemical Engineers which is co-operating with the Government in the disposition of chemical plants and surplus stocks of chemicals and apparatus.

MR. H. FOSTER BAIN, who has served as assistant director of the Bureau of Mines through the war period, has resigned to resume exploration in the Far East. He sails from Vancouver June 12.

DR. JOHN S. BATES, who for several years has been superintendent of the Dominion Government Forest Products Laboratories in Montreal, Can., has resigned to take a position with Price Bros. & Co., of Quebec.

COL. G. A. BURRELL, Pittsburgh, Pa., has been given the degree of Doctor of Science by Wesleyan University, Middletown, Conn. Last year his alma mater, Ohio State University, gave him the honorary degree of Chemical Engineer.

MR. J. J. CADOT, recently returned from military duty in France, has accepted a position with the Hardinge Conical Mill Co., at the Denver, Colo., office.

MR. E. H. CLAUSSEN, recently discharged from military service, is with the Mine & Smelter Supply Co., at 42 Broadway, N. Y.

MR. THOMAS E. FISHER has resigned from the Wharton Steel Co. and become connected with the Traylor Engineering & Manufacturing Co. of Allentown, Pa.

GEN. GEORGE W. GOETHALS, best known as the builder of the Panama Canal, was presented with the John Fritz medal at the Engineering Societies Building, New York, on May 22.

MR. ELLWOOD HENDRICK, consulting editor of *CHEMICAL & METALLURGICAL ENGINEERING*, delivered the last lecture

of a course before the Chemistry Club of the College of the City of New York on May 23, on "Some Chemists I Have Known." A large audience was present and listened to Mr. Hendrick's reminiscences and comments on Victor Meyer, Theodore W. Richards, Charles F. Chandler, Leo H. Baekeland and Irving Langmuir.

MR. R. W. HOVEY of the Forest Products Laboratories of Canada has resigned to accept a position with the Abitibi Power & Paper Co., at Iroquois Falls, Ont.

COL. DOUGLAS I. MCKAY has been elected president of the Pulverized Fuel Equipment Corp., New York, to succeed MR. JOHN E. MUHLFELD, who retires to return to consulting engineering practice.

MR. JOHN W. MALLER, until recently with W. R. Grace & Co., New York, has been appointed manager of the South American branch of the Ingersoll-Rand Co., with offices at Calle Merced 620, Lima, Peru.

MR. STUART B. MARSHALL, consulting engineer and metallurgist, has established his headquarters at Chevy Chase, Washington, D. C. He also retains his Roanoke, Va., address.

MR. CHARLES E. SHOLES has resigned from the Grasselli Chemical Co. to become vice-president and sales manager of the Edison Storage Battery Co. of Orange, N. J.

CAPT. EDWARD STEIDLE has recently returned from Europe to resume his work with the Carnegie Institute of Technology, Pittsburgh, Pa. He will devote his time to the development of a mining department which will be in close contact with the industry.

Current Market Reports

The Non-Ferrous Metal Market

Saturday, May 24.—Prices have tended to advance sharply with the prospects of an active market in sight.

Aluminium:—The open market is nominal at 33c. Sheets 18 gage and heavier, 42c. Powder, \$0.70-\$1.40 lb.

Antimony:—Antimony has advanced sharply with silver. Spot, 7½c. to 8¼c. lb.

Copper:—An advance in price is now taking place with spot at 16½c. and futures higher.

Copper sheets, hot-rolled.....	lb.	\$0.22	—	.....
Copper sheets, cold rolled.....	lb.	.23	—	.....
Copper bottoms.....	lb.	.23	—	.....
Copper rods.....	lb.	.19	—	.....
Copper wire.....	lb.	.17	—	\$0.18
High brass wire and sheets.....	lb.	.18	—	.....
High brass rods.....	lb.	.17	—	.....
Low brass wire and sheets.....	lb.	.18	—	.....
Low brass rods.....	lb.	.21	—	.....
Brass tubing.....	lb.	.29	—	.....
Brass bronze tubing.....	lb.	.33	—	.....
Seamless copper tubing.....	lb.	.28	—	.....
Seamless bronze tubing.....	lb.	.29	—	.....
Seamless brass tubing.....	lb.	.30	—	.....
Bronze (gold) powder.....	lb.	1.00	—	.....

Lead:—Lead is rising. New York asks 5½c. and East St. Louis 5c. lb. Sheet lead, 8c.

Tin:—Tin remains at 72½c.

Zinc:—Spelter has become firmer, advanced to 6.6c. to 6.75c. in New York and offers no low priced futures. East St. Louis quotes 6¼c. Zinc dust, 10c. Sheets, 12c.

OTHER METALS

Bismuth.....	lb.	\$3.20	—	\$3.65
Cadmium.....	lb.	1.40	—	.....
Cobalt.....	lb.	2.50	—	3.50
Magnesium.....	lb.	1.75	—	2.10
Mercury.....	75 lb.	92.00	—	.....
Nickel.....	lb.	.40	—	.45
Tungsten.....	lb.	Nominal	—	.....
Iridium.....	oz.	175.00	—	.....
Palladium.....	oz.	115.00	—	120.00
Platinum.....	oz.	105.00	—	.....
Silver.....	oz.	1.06	—	.....

The Iron and Steel Market

Developments in the iron and steel trade are being watched with much more interest than their intrinsic importance would merit, because knowledge of trends is desired. Since the signing of the armistice and the termination of war work not one single thing has occurred

in the iron and steel market that would furnish of itself an accurate guide to the future. For instance, last December certain price reductions occurred, but that did not prove that other declines were to occur, at either regular or irregular intervals, and the same observations apply to the reductions that occurred in March. Each decline in the market occurred with a particular stage setting, but that was not significant.

The latest development in the steel situation is the increase in buying that began about the middle of May. In point of volume the increase is not of much importance. At some periods in steel market history such an improvement would be accepted as indicating a definite trend. The conclusion would be reached that business was improving, and further improvement would be awaited with confidence. In this case, however, the character of the buying is what must be scrutinized, rather than the quantity, and its relation to the old orders with which some producing interests were well fortified at the war's ending, and which have been gradually playing out, must be considered.

CHARACTER OF THE BUYING

As to the character of buying, it is observed that it is the same as formerly obtained. The orders come from the same classes of buyers, jobbers and ordinary manufacturing consumers. There is little buying for strictly new construction purposes. The increased buying does not represent greater "confidence" in the market, for the buyers are making purchases, as formerly, only for immediate delivery, and even at that they frequently seek price guarantees, which as a rule they do not secure. The buyers are not stocking up. In some instances they may be enlarging their stocks, but not for the purpose of having larger stocks for the future; rather for the purpose of carrying on a larger volume of business at present. It may be that some increase in buying has been produced directly by the exhaustion of stocks carried at the end of the war. The country was not bare of steel then by any means.

The conclusion is that the common everyday needs of the people, in iron and steel, have increased in the past few weeks, and that new construction, on any large scale, has not commenced. As to the influence of the playing out of old orders, not enough time has elapsed to show what this increase in new buying means. The constantly decreasing steel production since the beginning of the year has been due to the gradual exhaustion of old orders. Month by month, for instance, the Steel Corporation's unfilled obligations have decreased, the losses being much greater than the new bookings, as shown by the fact that the loss each month has been much more than half the estimated shipments. The monthly report of steel ingot production has indicated steel mill operations, in proportion to rated capacity, as follows: January, 87 per cent; February, 85 per cent; March, 77 per cent; April, 65 per cent, and the indication has been that May would show about 55 per cent. Whether there is enough increase in new buying, in connection with this recent improvement, to counteract the influence of old orders being completed, is still to be disclosed.

NEW CONSTRUCTION

The construction firms and fabricating interests report that in the past few months they have figured upon large quantities of construction work, but practically no jobs of any magnitude have been authorized. The projects are not abandoned, simply deferred, and there is no definite information as to why the deferments have been made. The investors themselves would probably be unable to assign definite and clear-cut reasons, and they certainly could not make a precise statement as to the set of conditions under which, if developed, they would be willing to go ahead. The Bridge Builders' and Structural Society has reported lettings of fabricated steel jobs, in proportion to fabricating capacity, as follows: January, 12 per cent; February, 12½ per cent; March, 17½; April, 24½ per cent. Nothing more favorable can be said of these figures than that they show a trend in the right direction. The jobs let have all been small.

To engage the full capacity of the steel industry new construction in large volume is essential. More than half the steel normally passes into investment employment, and certainly no other alignment can be expected now, when steel making capacity is 40 per cent greater than in 1914.

RAILROAD REQUIREMENTS

It is traditional in the steel trade that there cannot be a full demand for steel unless the railroads are active buyers. The proportion of the total steel produced that passes to the railroads has been overestimated for years, perhaps partly because of the survival of old concepts based on conditions in the 1880's, when there was so much new construction of railroads. As a rough generalization it may be suggested that for normal upkeep of railroads between 10 and 15 per cent of the total steel that can be made is required, while anything like an extensive program of railroad expansion and development would double the tonnage. Under the most favorable conditions the railroads might take 25 to 30 per cent of the total steel that could be produced. In the past it has been only when the railroads were taking large tonnages that the steel industry was really busy.

For the remainder of this year the railroads will require very little steel. Analysis of the 1918 rail production statistics indicated that the steam roads had about 1,400,000 tons for replacement purposes, and at the beginning of this year it is understood that there was about 1,200,000 tons due them on old orders. On May 23 the Railroad Administration placed orders for 200,000 tons of rails, this being the mouse that came forth when the labors of the Industrial Board were abandoned. The tonnages for last year and this are ample for necessary replacement purposes. The railroads could lay many hundreds of thousands of tons of rails in addition, slightly improving the permanent way, but that would be a luxury not to be thought of in present circumstances. As to other steel requirements, a careful canvass of the situation has recently been made, disclosing that by some redistribution of material the railroads can get along to the end of the year with little additional steel beyond what is in stock at one point or another, or on order, for car and locomotive repair and ordinary upkeep in other directions.

PRICES

The steel producers show little disposition to depart from the prices that became effective March 21. They are educated to adhere to existing prices, whatever they may be, unless they can effect advances, for they have no means of making clear-cut reductions and adhering to the new prices with the same fidelity as they showed with the previous prices. As long as there is no definite prospect that a break in the market would result in filling the mills and thus paving the way for an advancing market again, the mills are likely to make every effort to maintain the present schedules. Whenever they become convinced that the time is ripe for the starting of a general buying movement they will probably let down the bars, since it is traditional that such buying movement can thrive only on an advancing market. If when the time comes the market will not advance from the existing level, it will be necessary to provide it with a level from which it will advance.

The Chemical Market

New York, May 28.

Most of the job lots which were dumped on the market as soon as the armistice was signed, together with the quantities of salvage goods offered by the Government, have been absorbed. Soon the manufacturers' influence should be felt in a strengthened market. Furthermore, with the Government inclined toward protection, manufacturers are encouraged to bend every effort to meet the foreign competition which will follow the signing of the peace terms.

Inquiries, both domestic and for export, appear to show some improvement. Instead of being mere requests for prices, the inquiries are beginning to have substance.

Although the quoted price on caustic soda has under-

gone no change a perceptible strengthening of the market is seen. This is attributed to the increased domestic consumption and the demand for export, which have exhausted the war stocks. Japan has been the heaviest buyer.

There is a good demand for acetic acid, much of it being sold for export. However, the large stocks held by producers do not seem to have been affected and this commodity remains weak.

Unrest has been generated in the potash market by the arrival last week of 4000 bags of raw potash salts from Alsace-Lorraine and by the anticipation of further shipments from there, together with probable shipments from Germany within a few months. However, it is believed in most quarters that the Government will take a hand in regulating Germany's shipments. One house reports a large shipment of caustic potash and potassium carbonate to Denmark.

Sodium bichromate is weak due to the reduction in cost of the raw material from which it is made. Sodium sulphide is active, South American demand being the reason. The manufacturers are still maintaining the price of 43c. a lb. for it, but second hands are shading this to the export trade.

With the textile mills settling down to work again, there is a strong demand for oxalic acid. Largely to stimulate trade, formaldehyde has dropped to 20-21c. Increased commercial demand, together with the depletion of war stocks, has stiffened glycerine. The sale of a carload of dynamite glycerine at 20½c. caused a general advance to 21c. Oxide of tin remains lower in price owing to the low price levels of some of its substitutes.

Of particular interest is the proposed formation of a \$15,000,000 export company to represent the leading chemical manufacturers of the country.

WAXES:—There is a good demand for waxes, particularly carnauba. Last week 4400 bags of carnauba were placed on the market, making a record stock. Yet in the face of this the price of carnauba rose. Paraffine waxes declined because of lessened demand and the fact that manufacturers, having large quantities on hand, desire to stimulate business. Japan wax is selling at a high mark owing to scarcity of spot stock and the high price of tallow, with which it is sympathetic.

COAL-TAR PRODUCTS:—No increased activity among any of the crudes is noted; intermediates, however, are beginning to pick up. From all quarters comes the report that both domestic and export inquiries are improving. The export phase is hampered by the inability to procure shipping space.

OILS:—Vegetable oils show great activity with rapidly advancing prices. The main factor is the heavy export demand caused by the dearth of fats in Europe. Demand for all the vegetable oils has depleted stocks, resulting in a speculative market. The top price has not been reached.

In spite of a decline in linseed oil, due to smallness of demand, it is predicted that the short supply of seed will soon cause prices to soar.

SHELLAC:—Stocks of shellac are the lowest they have ever been, while prices are the highest ever attained in the history of the trade. There are practically no spot stocks of any grade. Of TN, the shellac on which the price of all the other grades is based, none is to be had at any price. The same is true of the other grades, with the exception of orange, fine, super-fine and A.C. garnet. The supply of these is limited and will soon be exhausted. Consumers are willing to buy any grade and at any price.

In normal times the price of TN holds close to 38c. a lb., the highest being \$0.638 in 1875, the lowest \$0.088 in 1888. The present price is nominal, but the situation will improve as soon as an expected consignment from Calcutta arrives.

The present situation is due not to the scarcity in the supply of shellac in India, but rather to the policy followed by the consumers. They reasoned that with the embargoes imposed by the war and the dangers to shipping removed the market was certain to decline. The market did decline and the buying was for immediate needs

only. At the same time, while buying continued on this basis, dealers did not care to assume the risk of carrying surplus stocks. Then the market began to rise due to scarcity of spot stocks with the result that consumers rushed into the market and dealers had not enough stock on hand to supply the sudden demand.

Chicago, May 24.

Trade conditions in chemical lines continue to register the improvement indicated the first part of this month. With second hand stocks becoming materially reduced and nearly all prices either showing a slight advance or remaining firm, the tendency of buyers is toward longer term buying. The stabilizing market has caused buyers to seem more satisfied with dealers' offerings, and reflects generally a much more satisfactory condition than obtained during the preceding four months.

Jobbers state that gross sales are larger for May than in the corresponding month last year, yet still under those of last fall. With collections good a decidedly optimistic tone is noted.

Heavy chemicals are having a very slow recovery, caustic soda and bleach still being weak, but soda ash in fair demand with the price firm. Few changes in acids are noted, demand more nearly approximating supply than in the recent past. Carbolic is finding a fairly ready sale at 9 cents.

No price differences have developed in coal-tar products, benzol standing at 25c. No particularly large contracts have been noted, sales of small lots being the feature of the market, the movement being sufficient to prevent any accumulation of overstock.

The previously noted good market in vegetable oils is still in effect, with every indication of long continued similar conditions. The recent destruction of the Douglas Starch Works at Cedar Rapids, Iowa, by an explosion which was fatal to a large number of men, involved the loss of quantities of corn oil, and is having an immediate effect of further stiffening prices in this entire line.

Naval stores and flotation oils continue in excellent demand. No appreciable price changes are noted.

St. Louis, Mo., May 26.

A decided improvement in most branches of the heavy chemical market at St. Louis is reported by producers and traders to have manifested itself within the last week or two. Sulphuric acid, especially, the key item of the heavy chemical market, was more sought for than at any time since the signing of the armistice, it is reported.

Both inquiries and actual sales are more frequent and of heavier volume now than for many weeks. The revival in trading in the acids has given a firmer tone to the chemical market generally. The business of the last week, well informed men say, represents no mere temporary spurt of buying, but an actual resumption of activities in certain industries that have been very quiet or at a standstill since the cessation of hostilities.

Sulphuric Acid:—Of 60 degrees, a large supply is on hand. Comparatively heavy sales are reported for the last fortnight at around \$12.50 a ton; 66-deg. acid is quoted at \$18 a ton.

Muriatic Acid:—A fair business is being done in this line, producers say, and inquiries are increasing; \$22 a ton for 18-deg. is quoted.

Nitric Acid:—This branch of the market remains stationary; very little trading is in progress and the price remains unchanged at 9½c. per pound for 38-deg.

Zinc Chloride:—A very good demand for this chemical is apparent here. It seems that the Railroad Administration is giving the creosoting people a good deal of work and this is being reflected in an increased demand for zinc chloride. The prevailing quotation is 4½c. per pound.

Sodium Sulphate:—Salt cake is quoted at \$20 a ton and is in better demand than for some time in the past.

Sodium Bisulphate:—Niter cake is quoted at \$3 a ton, with no demand at present, as the glass-manufacturing season does not open until Aug. 15. It is expected, from the character of present inquiries for this item, that business will be resumed about July 1.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET MAY 28, 1919

Acetic anhydride.....	lb.	.54	.60
Acetone.....	lb.	.15	.15
Acid, acetic, 28 per cent.....	cwt.	2.50	3.00
Acetic, 56 per cent.....	cwt.	5.50	6.00
Acetic, glacial, 99 1/2 per cent, carboys.....	cwt.	12.00	14.00
Boric, crystals.....	lb.	.13	.14
Boric, powder.....	lb.	.13	.14
Hydrochloric, tech. 20 deg.....	cwt.	1.50	3.00
Hydrofluoric, 52 deg.....	lb.	.08	.09
Lactic, 44 per cent, tech.....	lb.	.14	.17
Lactic, 22 per cent, tech.....	lb.	.05	.06
Molybdic, C. P.....	lb.	6.50	7.40
Nitric, 40 deg.....	lb.	.07	.08
Nitric, 42 deg.....	lb.	.07	.08
Oxalic, crystals.....	lb.	.23	.28
Phosphoric, Ortho, 50 per cent, solution.....	lb.	.07	.10
Picric.....	lb.	.75	.85
Pyrogallol, resublimed.....	lb.	2.50	2.55
Sulphuric, 66 deg., tank cars.....	ton	11.00	13.00
Sulphuric, 60 deg., drums.....	ton	17.00	17.00
Sulphuric, 60 deg., carboys.....	ton	20.00	20.00
Sulphuric, 66 deg., tank cars.....	ton	16.00	18.00
Sulphuric, 66 deg., drums.....	ton	21.00	21.00
Sulphuric, 66 deg., carboys.....	ton	25.00	25.00
Sulphuric, fuming, 20 per cent, (oleum) tank cars.....	ton	20.00	22.00
Sulphuric, fuming, 20 per cent, (oleum) drums.....	ton	25.00	25.00
Sulphuric, fuming, 20 per cent, (oleum) carboys.....	ton	30.00	30.00
Tannic, U. S. P.....	lb.	1.30	1.40
Tannic, (tech).....	lb.	.42	.60
Tartaric, crystals.....	lb.	.82	.85
Tungstic, per lb. of WO ₃	lb.	1.25	1.50
Alcohol, Ethyl.....	gal.	4.00	4.85
Alcohol, Methyl.....	gal.	1.25	1.30
Alum, ammonia lump.....	lb.	.04	.05
Alum, potash lump.....	lb.	.08	.10
Alum, chrome lump.....	lb.	.15	.15
Aluminium sulphate, commercial.....	lb.	.01	.03
Aluminium sulphate, iron free.....	lb.	.02	.03
Aqua ammonia, 26 deg., carboys.....	lb.	.06	.08
Ammonia, anhydrous, cylinders (100-150 lbs.).....	lb.	.30	.30
Ammonium carbonate, powder.....	lb.	.12	.13
Ammonium chloride, granular (white sal ammoniac).....	lb.	.13	.14
Ammonium chloride, granular (gray sal ammoniac).....	lb.	.13	.14
Ammonium nitrate.....	lb.	.17	.20
Ammonium sulphate.....	lb.	.05	.06
Amyl acetate.....	gal.	3.50	3.75
Arsenic, oxide, lumps.....	lb.	.09	.09
Arsenic, sulphide, powdered.....	lb.	.30	.32
Barium chloride.....	ton	80.00	90.00
Barium dioxide (peroxide).....	lb.	.19	.24
Barium nitrate.....	lb.	.11	.11
Barium sulphate (precip.) (blanc fixe).....	lb.	.01	.03
Bleaching powder (see calcium hypochlorite).....	lb.	.01	.03
Blue Vitriol (see copper sulphate).....	lb.	.....	.....
Borax (see sodium borate).....	lb.	.....	.....
Brimstone (see sulphur, roll).....	lb.	.....	.....
Bromine.....	lb.	.40	.50
Calcium acetate.....	lb.	.04	.05
Calcium carbide.....	lb.	.05	.06
Calcium chloride, fused, lump.....	ton	19.00	25.00
Calcium chloride, granulated.....	lb.	.01	.02
Calcium hypochlorite, (bleaching powder).....	cwt.	1.50	2.00
Calcium peroxide.....	lb.	1.50	1.70
Calcium phosphate, monobasic.....	lb.	.22	.23
Calcium sulphate, precipitated.....	lb.	.09	.09
Carbon bisulphide.....	lb.	.05	.06
Carbon tetrachloride, drums.....	lb.	.13	.14
Carbonyl chloride (phosgene).....	lb.	.75	1.00
Caustic potash (see potassium hydroxide).....	lb.	.....	.....
Caustic soda (see sodium hydroxide).....	lb.	.....	.....
Chlorine, gas, liquid-cylinders, (100 lb.).....	lb.	.05	.08
Cobalt oxide.....	lb.	1.60	1.65
Copperas (see iron sulphate).....	lb.	.....	.....
Copper carbonate, green precipitate.....	lb.	.28	.31
Copper cyanide.....	lb.	.65	.70
Copper sulphate, crystals.....	lb.	.07	.08
Cream of tartar, (see potassium bitartrate).....	lb.	.....	.....
Epsom salt (see magnesium sulphate).....	lb.	.20	.21
Formaldehyde, 40 per cent.....	lb.	.21	.23
Glauber's salt (see sodium sulphate).....	lb.	.21	.23
Glycerine.....	lb.	4.25	4.30
Iodine, resublimed.....	lb.	.06	.06
Iron oxide, red.....	lb.	1.00	1.75
Iron sulphate (copperas).....	cwt.	1.00	1.75
Lead acetate, normal.....	lb.	.12	.15
Lead arsenate (paste).....	lb.	.15	.18
Lead nitrate, crystals.....	lb.	.85	.86
Litharge.....	lb.	.09	.10
Lithium carbonate.....	lb.	1.50	1.50
Magnesium carbonate, technical.....	lb.	.12	.14
Magnesium sulphate, U. S. P.....	100 lb.	2.00	2.50
Magnesium sulphate, commercial.....	100 lb.	2.25	2.50
Nickel salt, double.....	lb.	.13	.15
Nickel salt, single.....	lb.	.11	.14
Phosgene (see carbonyl chloride).....	lb.	.....	.....
Phosphorus, red.....	lb.	.75	.80
Phosphorus, yellow.....	lb.	.35	.37
Potassium bichromate.....	lb.	.29	.33
Potassium bitartrate, (cream of tartar).....	lb.	.52	.55
Potassium bromide, granular.....	lb.	.49	.50
Potassium carbonate, U. S. P.....	lb.	.65	.70
Potassium carbonate, crude.....	lb.	.11	.14
Potassium chlorate, crystals.....	lb.	.25	.31
Potassium cyanide, 98-99 per cent.....	lb.	Nominal	.45
Potassium hydroxide, (caustic potash).....	lb.	.35	.40
Potassium iodide.....	lb.	3.50	3.40
Potassium nitrate.....	lb.	.19	.22
Potassium permanganate.....	lb.	.60	.75
Potassium prussiate, red.....	lb.	.34	.45
Potassium prussiate, yellow.....	lb.	.34	.45
Potassium sulphate.....	ton	225.00	225.00
Rochelle salt (see sodium potassium tartrate).....	lb.	.....	.....
Sal ammoniac (see ammonium chloride).....	lb.	.....	.....
Sal soda (see sodium carbonate).....	lb.	.....	.....
Salt cake.....	ton	14.00	14.00
Silver cyanide.....	oz.	1.19	1.19
Silver nitrate.....	oz.	.68	.70

Soda ash, light.....	100 lb.	1.50	1.75
Soda ash, dense.....	100 lb.	1.85	2.00
Sodium acetate.....	lb.	.06	.08
Sodium bicarbonate.....	100 lb.	2.35	2.50
Sodium bichromate.....	lb.	.09	.10
Sodium bisulphate, (nitro cake).....	ton	3.00	10.00
Sodium bisulphate.....	lb.	.05	.07
Sodium borate, (borax).....	lb.	.07	.08
Sodium carbonate (sal soda).....	100 lb.	1.30	1.60
Sodium chlorate.....	lb.	.15	.18
Sodium cyanide.....	lb.	.30	.31
Sodium fluoride.....	lb.	.14	.15
Sodium hydroxide, (caustic soda).....	100 lb.	2.50	2.75
Sodium molybdate.....	lb.	2.50	2.50
Sodium nitrate.....	100 lb.	4.07	4.07
Sodium nitrite.....	lb.	.11	.13
Sodium peroxide, powdered.....	lb.	.25	.30
Sodium phosphate, dibasic.....	lb.	.03	.03
Sodium potassium tartrate (Rochelle salt).....	lb.	.43	.45
Sodium prussiate, yellow.....	lb.	.16	.20
Sodium silicate, solution (40 deg.).....	lb.	.01	.02
Sodium silicate, solution, (60 deg.).....	lb.	.02	.04
Sodium sulphate, crystals, (Glauber's salt).....	cwt.	1.25	1.50
Sodium sulphide, crystal, 60-62 per cent, (cone).....	lb.	.04	.05
Sodium sulphite, crystals.....	lb.	.03	.04
Strontium nitrate, crystals.....	lb.	.25	.30
Sulphur chloride.....	lb.	.05	.05
Sulphur, crude.....	ton	35.00	37.50
Sulphur dioxide, liquid, cylinders.....	lb.	.10	.12
Sulphur, (sublimed), flowers.....	100 lb.	3.05	3.60
Sulphur, roll, (brimstone).....	100 lb.	2.70	3.65
Tin bichloride, (stannous).....	lb.	.22	.25
Tin oxide.....	lb.	.60	.....
Zinc carbonate, precipitate.....	lb.	.18	.20
Zinc chloride, gran.....	lb.	.13	.14
Zinc cyanide.....	lb.	.49	.50
Zinc dust.....	lb.	.09	.11
Zinc oxide, dry American.....	lb.	.09	.11
Zinc sulphate.....	lb.	.03	.04

Coal Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude.....	lb.	1.00	1.10
Alpha naphthol, refined.....	lb.	1.40	1.50
Alpha naphthylamine.....	lb.	.40	.50
Aniline oil, drums extra.....	lb.	.22	.24
Aniline salts.....	lb.	.28	.33
Anthracene, 80% in drums (100 lb.).....	lb.	.90	1.00
Benzaldehyde (f.f.c.).....	lb.	1.00	1.15
Benzidine, base.....	lb.	1.00	1.15
Benzidine, sulphate.....	lb.	.90	1.10
Benzoic acid, U. S. P.....	lb.	1.00	1.10
Benzoate of soda, U. S. P.....	lb.	.95	1.10
Benzol, pure, water-white, in drums (100 lb.).....	gal.	.22	.27
Benzol, 90% in drums (100 lb.).....	gal.	.22	.27
Benzyl chloride, 95-97% refined.....	lb.	.35	.40
Benzyl chloride, tech.....	lb.	.25	.35
Beta naphthol benzoate.....	lb.	4.00	4.50
Beta naphthol, sublimed.....	lb.	.75	.80
Beta naphthol, tech.....	lb.	.45	.55
Beta naphthylamine, sublimed.....	lb.	2.25	2.35
Cresol, U. S. P., in drums (100 lb.).....	lb.	.18	.....
Ortho-cresol, in drums (100 lb.).....	lb.	.23	.25
Cresylic acid, 97-99%, straw color, in drums.....	gal.	1.00	1.02
Cresylic acid, 95-97%, dark, in drums.....	gal.	.90	.92
Cresylic acid, 50%, first quality, drums.....	gal.	.60	.....
Dichlorobenzol.....	lb.	.07	.10
Diethylaniline.....	lb.	1.75	2.25
Dimethylaniline.....	lb.	.50	.57
Dinitrobenzol.....	lb.	.25	.35
Dinitrochlorobenzol.....	lb.	.25	.28
Dinitronaphthalene.....	lb.	.45	.55
Dinitrotoluenol.....	lb.	.38	.45
Dinitrophenol.....	lb.	.30	.32
Dip oil, 25% tar acids, car lots, in drums.....	gal.	.38	.46
Diphenylamine.....	lb.	.70	.75
H-acid.....	lb.	1.90	2.25
Metaphenylenediamine.....	lb.	1.20	1.80
Monochlorobenzol.....	lb.	.10	.14
Monoethylaniline.....	lb.	1.50	1.75
Naphthalene, crushed in bbls. (250 lb.).....	lb.	.06	.08
Naphthalene, flake.....	lb.	.07	.08
Naphthalene, balls.....	lb.	.10	.11
Naphthionic acid, crude.....	lb.	1.00	1.25
Nitrobenzol.....	lb.	.13	.15
Nitro-naphthalene.....	lb.	.40	.45
Nitro-toluenol.....	lb.	.17	.20
Ortho-amidophenol.....	lb.	6.00	.....
Ortho-dichlorobenzol.....	lb.	.15	.20
Ortho-nitro-phenol.....	lb.	1.25	.....
Ortho-toluidine.....	lb.	.40	.45
Ortho-nitro-toluenol.....	lb.	.35	.50
Para-amidophenol, base.....	lb.	2.75	3.50
Para-amidophenol, H. Cl.....	lb.	3.00	3.25
Para-dichlorobenzol.....	lb.	.06	.10
Paranitraniline.....	lb.	1.10	1.25
Para-nitro-toluenol.....	lb.	1.35	1.50
Paraphenylenediamine.....	lb.	3.00	3.25
Para-toluidine.....	lb.	1.50	1.75
Phthalic anhydride.....	lb.	1.75	2.15
Phenol, U. S. P. drums (dest.), (240 lb.).....	lb.	.08	.09
Pyridin.....	gal.	\$2.50	.....
Resorcin, technical.....	lb.	3.50	3.75
Resorcin, pure.....	lb.	6.50	7.75
Salicylic acid, tech., in bbls. (110 lb.).....	lb.	.20	.30
Salicylic acid, U. S. P.....	lb.	.25	.35
Salol.....	lb.	.75	.85
Solvent naphtha, water white, in drums, 100 gal.....	gal.	.20	.25
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.18	.20
Sulphanilic acid, crude.....	lb.	.25	.30
Toluidine.....	lb.	2.15	2.50
Toluidine, mix. d.....	lb.	.45	.80
Toluenol, in tank cars.....	gal.	.22	.24
Toluenol, in drums.....	gal.	.23	.30
Xylidine, drums, 100 gal.....	lb.	.40	.45
Xylol, pure, in drums.....	gal.	.37	.45
Xylol, pure, in tank cars.....	gal.	.35	.....
Xylol, commercial, in drums, 100 gal.....	gal.	.30	.40
Xylol, commercial, in tank cars.....	gal.	.30	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow.....	lb.	.39	—	.40
Beeswax, refined, yellow.....	lb.	.44	—	.47
Beeswax, white pure.....	lb.	.62	—	.65
Carnauba, No. 1.....	lb.	.80	—	.83
Carnauba, No. 2, regular.....	lb.	.65	—	.72
Carnauba, No. 2, North Country.....	lb.	.50	—	.55
Carnauba, No. 3, North Country.....	lb.	.42	—	.44
Ceresin, yellow.....	lb.	.16	—	.18
Ceresin, white.....	lb.	.18	—	.20
Japan.....	lb.	.14	—	.18
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.07	—	.08
Paraffine waxes, crude scale, 117-119 m.p.....	lb.	.07	—	.08
Paraffine waxes, crude scale, 124-126 m.p.....	lb.	.07	—	.08
Paraffine waxes, refined, 118-120 m.p.....	lb.	.09	—	.09
Paraffine waxes, refined, 123-125 m.p.....	lb.	.09	—	.10
Paraffine waxes, refined, 128-130 m.p.....	lb.	.09	—	.10
Paraffine waxes, refined, 130-132 m.p.....	lb.	.10	—	.11
Paraffine waxes, refined, 133-135 m.p.....	lb.	.11	—	.12
Paraffine waxes, refined, 135-137 m.p.....	lb.	.12	—	.13
Stearic acid, single pressed.....	lb.	.18	—	.19
Stearic acid, double pressed.....	lb.	.19	—	.21
Stearic acid, triple pressed.....	lb.	.22	—	.24
Spermaceti.....	lb.	.30	—	.32

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lbs.

Pine oil, steam dist., sp. gr. 0.930-0.940.....	gal.	\$0.68	—	
Pine tar oil, ref., sp. gr. 1.025-1.035.....	gal.	.45	—	
Pine tar oil, ref., sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla., gal.....	gal.	.33	—	
Pine tar oil, double ref., sp. gr. 0.965-0.990.....	gal.	.58	—	
Pine tar, ref., thin, sp. gr. 1.080-1.960.....	gal.	.38	—	
Turpentine, crude, sp. gr. 0.900-0.970.....	gal.	.61	—	
Hardwood oil, f.o.b. Mich., sp. gr. 0.960-0.990.....	gal.	.24	—	
Hardwood oil, f.o.b. Mich., sp. gr. 1.06-1.08.....	gal.	.24	—	
Pine wood creosote, ref.....	gal.	.48	—	

Naval Stores

The following prices are F.o.b., New York, for earload lots.

Rosin B-D, bbl.....	280 lb.	\$12.00	—	\$12.55
Rosin E-I.....	280 lb.	12.70	—	12.75
Rosin K-N.....	280 lb.	14.05	—	14.25
Rosin W. G.-W. W.....	280 lb.	15.05	—	15.60
Wood rosin, bbl.....	280 lb.	12.25	—	
Spirits of Turpentine.....	gal.	.81	—	.78
Wood Turpentine, steam dist.....	gal.	.75	—	
Wood Turpentine, dest. dist.....	gal.	.69	—	
Pine tar pitch, bbl.....	200 lb.	8.00	—	8.25
Tar, kiln burned, bbl. (500 lbs.).....	bbl.	12.50	—	13.50
Retort tar, bbl.....	280 lb.	13.50	—	14.50
Rosin oil, first run.....	gal.	.68	—	.76
Rosin oil, second run.....	gal.	.70	—	.80
Rosin oil, third run.....	gal.	.82	—	.83
Rosin oil, fourth run.....	gal.	.85	—	.95

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.34	—	
70-72 deg., steel bbls. (85 lb.).....	gal.	.31	—	
68-70 deg., steel bbls. (85 lb.).....	gal.	.30	—	
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.23	—	

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls.....	lb.	\$0.21	—	\$0.23
Castor oil, AA, in bbls.....	lb.	.23	—	.24
China wood oil, in bbls.....	lb.	.18	—	.21
Cocoonut oil, Ceylon grade, in bbls.....	lb.	.15	—	.16
Cocoonut oil, Cochon grade, in bbls.....	lb.	.17	—	.18
Corn oil, crude, in bbls.....	lb.	.19	—	.20
Cottonseed oil, crude (f.o.b. mill).....	lb.	.17	—	.17
Cottonseed oil, summer yellow.....	lb.	.21	—	.25
Cottonseed oil, winter yellow.....	lb.	.24	—	.25
Linseed oil, raw, car lots.....	gal.	1.56	—	1.58
Linseed oil, raw, tank cars.....	gal.	1.52	—	1.56
Linseed oil, boiled, car lots.....	gal.	1.58	—	1.60
Olive oil, commercial.....	gal.	2.10	—	2.25
Palm, Lagos.....	lb.	.15	—	.18
Palm, bright red.....	lb.	.15	—	.16
Palm, Niger.....	lb.	.14	—	.15
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.19	—	.22
Peanut oil, refined, in bbls.....	lb.	.22	—	.24
Rapeseed oil, refined, in bbls.....	gal.	1.50	—	1.55
Rapeseed oil, blown, in bbls.....	gal.	1.58	—	1.60
Soya bean oil (Manchurian), in bbls., N. Y.....	gal.	.16	—	.17
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.15	—	.16

FISH

Winter pressed Menhaden.....	gal.	\$0.89	—	
Yellow bleached Menhaden.....	gal.	.91	—	
White bleached Menhaden.....	gal.	.93	—	
Blown Menhaden.....	gal.	.99	—	

Miscellaneous Materials

All Prices F.o.b., N. Y.

Barytes, domestic, white, floated.....	ton	\$25.00	—	\$36.00
Barytes, off color.....	ton	22.00	—	27.00
Blanc fixe, dry.....	lb.	.03	—	.04
Blanc fixe, pulp.....	ton	30.00	—	45.00
Casolin.....	lb.	.16	—	.18
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.04	—	.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay (Kaolin), imported, lump.....	ton	35.00	—	
China clay (Kaolin), imported, powdered.....	ton	60.00	—	
China clay (Kaolin), domestic, lump.....	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered.....	ton	25.00	—	40.00
Feldspar.....	ton	11.00	—	15.00

Fluorspar, acid grade, lump, f.o.b. mines.....	net ton	30.00	—	35.00
Fluorspar, acid grade, ground, f.o.b. mines.....	net ton	35.00	—	40.00
Fuller's earth, domestic, powdered.....	ton	30.00	—	40.00
Fuller's earth, imported, powdered.....	ton	—	—	—
Pumice stone, imported.....	lb.	.03	—	.06
Pumice stone, domestic.....	lb.	.02	—	
Shellac, TN.....	lb.	.60	—	
Shellac, D.C.....	lb.	—	—	
Shellac, V. S. O.....	lb.	—	—	
Shellac, Diamond I.....	lb.	—	—	
Shellac, orange, fine.....	lb.	.73	—	
Shellac, orange, superfine.....	lb.	.75	—	
Shellac, A.C. garnet.....	lb.	.63	—	
Shellac, bleached, bone dry.....	lb.	—	—	
Shellac, bleached, fresh ground.....	lb.	—	—	
Soapstone.....	ton	15.00	—	25.00
Talc, domestic.....	ton	16.00	—	60.00
Talc, imported.....	ton	55.00	—	60.00

Refractories

Following prices are f. o. b. works:

Chrome brick.....	net ton	90-100 at Chester, Penn.	
Chrome cement.....	net ton	45-50 at Chester, Penn.	
Clay brick, 1st quality fireclay.....	net ton	35-45 at Clearfield, Penn.	
Clay brick, 2nd quality.....	net ton	30-35 at Clearfield, Penn.	
Magnesite, dead burned.....	net ton	50-55 at Chester, Penn.	
Magnesite brick, 9 x 4 1/2 x 2 1/2 in.....	net ton	80-90 at Chester, Penn.	
Silica brick.....	net ton	41-45 at Mt. Union, Penn.	

Ferro-alloys

All prices f. o. b. works.

Ferro-carbon-titanium, 15-18%, f. o. b. Niagara Falls, N. Y.....	net ton	\$220.00	—	
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon.....	lb.	.32	—	.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon.....	lb.	.70	—	
Ferro-manganese, 70-80% Mn.....	gross ton	110.00	—	125.00
Spiegeleisen, 16-20% Mn.....	gross ton	40.00	—	50.00
Ferro-molybdenum, per lb. of Mo.....	lb.	2.50	—	3.00
Ferro-silicon, 50%.....	gross ton	90.00	—	115.00
Ferro-silicon, 75%.....	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%.....	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	1.30	—	1.60
Ferro-uranium, 35-50% of U.....	lb.	7.00	—	
Ferro-vanadium, 30-40%, per lb. of contained V.....	lb.	6.00	—	7.00

Resales and overstocks make above prices approximate.

Ores and Semi-finished Products

Chrome ore, 35-40%, Cr ₂ O ₃	unit	\$0.70	—	
Chrome ore, 48% and over.....	unit	1.00	—	\$1.25
Coke, foundry, f.o.b. mines.....	net ton	4.50	—	5.00
Coke, furnace, f.o.b. mines.....	net ton	4.00	—	5.00
Petroleum coke, f.o.b. Atlantic seaboard.....	net ton	16.00	—	16.50
Fluorspar, gravel, f.o.b. mines.....	net ton	18.50	—	20.00
Manganese ore, 45% Mn and over.....	unit	.50	—	.85
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	70.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO ₃ and over per unit of WO ₃	unit	9.00	—	10.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃	unit	6.50	—	8.00
Uranium oxide, 96%.....	lb.	—	—	
Vanadium pentoxide, 99%.....	lb.	6.00	—	
Pyrites, foreign, lump.....	unit	.17	—	
Pyrites, foreign, fine.....	unit	.17	—	
Pyrites, domestic, fine.....	unit	.14	—	
Ilmenite, 50% TiO ₂	net ton	30.00	—	
Rutile, 95% TiO ₂	net ton	200.00	—	
Carnotite, minimum 2% U ₃ O ₈ , per lb. of U ₃ O ₈	lb.	3.00	—	3.25

Resales and overstocks make above prices approximate.

Plant Materials and Supplies

In earload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags.....	bbl.	\$2.30	
Lump lime, common, including container.....	300 bbl.	2.65	
Common brick, at dock.....	M.	15.00	
Hollow building tile.....	M.	194.40	
At factory, Perth Amboy, N. J., 8x12x12.....	M.	291.60	
Yellow pine, 3x4 to 8x8, 20-24 ft. long.....	M.	39.00	
Yellow pine, 3x4 to 8x8, 20-24 ft. long at Chicago.....	M.	38.50	
Yellow pine, 3x4 to 8x8, 20-24 ft. long at St. Louis.....	M.	35.00	
Roofings, tar felt (14 lb. per 100 sq.ft.).....	ton	50.00	
Roofings, tar pitch (in 400-lb. bbl.).....	ton	19.00	
Roofings, asphalt felt.....	ton	30.00	
Roofings, slate-surfaced shingles, per roll of 100 sq.ft.....	ton	65.00	
Roofings, slate-finished shingles, 100 sq.ft.....	ton	2.10	
Linseed oil, raw in barrels.....	gal.	\$1.63	
Linseed oil, 5 gal. cans.....	gal.	1.76	
Red lead, dry, 100 lb. keg.....	lb.	.13	
Red lead, in oil, 100 lb. keg.....	lb.	.14	
Red lead, dry, 5 lb. cans.....	lb.	.13	
Red lead, in oil, 5 lb. cans.....	lb.	.16	
White lead, dry and in oil, 100 lb. keg.....	lb.	.13	
White lead, dry and in oil, 25 and 50 lb. kegs.....	lb.	.13	
White lead, dry and in oil, 5 lb. cans.....	lb.	.15	

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.....	100 lb.	\$2.45	
Angles, 3 to 6-in., 1-in. thick.....	100 lb.	2.45	
Tees, 3-in. and larger.....	100 lb.	2.45	
Plates.....	100 lb.	2.66	
Rivets, structural 1-in. and larger.....	100 lb.	4.20	
Rivets, conchard for boilers, 1-in. and larger.....	100 lb.	4.30	
Sheets, No. 28 black.....	100 lb.	4.35	
Sheets, No. 10 blue annealed.....	100 lb.	3.55	
Sheets, No. 28 galvanized.....	100 lb.	5.70	

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

ALBANY—The Southern Cotton Oil Co., First National Bank Bldg., Montgomery, plans to increase the capacity of its mixing plant to 10,000 tons and build a gin with 72-bale capacity near the oil mill here. Estimated cost, \$50,000.

Arizona

PHOENIX—The city has had plans prepared by H. Phillips, consulting engineer, International Life Bldg., St. Louis, Mo., for a gravity water supply from the Verde River, to include filtration system, 42-in. pipe line and 25,000,000-gal. concrete reservoir. Estimated cost, \$1,350,000.

TUCSON—Hereford & Hubbard plan to install a 100-ton concentration float mill on the Bannet property.

California

BISHOP—A. D. Schiveley, city clerk, will receive bids until June 2 for the construction of a sanitary sewerage system and sewage treatment tank. Olmsted & Gillette, 1112 Hollingsworth Bldg., Los Angeles, engineers.

EMERYVILLE—The Sherwin Williams Co., 454 2nd St., San Francisco, will soon award the contract for the construction of a 2-story paint and varnish factory on the old race track, here.

HUNTINGTON BEACH—The city plans an election soon to vote on \$40,000 bonds for rebuilding its gas plant. Olmsted & Gillette, Hollingsworth Bldg., Los Angeles, engineers.

Connecticut

HARTFORD—The city has awarded the contract for the construction of a filtration plant, to the Foundation Co., 233 Broadway, New York City, N. Y. Estimated cost, \$627,507. Noted Mar. 1.

Illinois

CHICAGO—J. McGillen, clerk sanitary district, Room 700, 910 South Michigan Ave., has awarded the contract for the construction of the Des Plaines River sewage treatment works, Division A, sewage treatment plant, to Leyden-Ortselmer Co., 53 Jackson Blvd., \$384,281; Division P, electrical equipment, to the W. A. Jackson Co., 37 West Van Buren St., \$22,795; Division W, venturi meters, to the Builders Iron Foundry, 209 South La Salle St., \$12,760.

ROCKFORD—A. C. Woods & Co., engineers, plan to build a fabricating plant here.

Indiana

WHITING—The Board of Public Works will receive bids until June 2 for building a water system: (a) mechanical water-filtration plant, gravity type, 4,000,000-gal. per day capacity, including aerating basin, coagulating basin, filters, reservoir, head house; making connections with the city mains and the erection of equipment specified in (b); (b) one 5,000,000-gal. centrifugal pump, two 5,000,000-gal. centrifugal pumps, one 3,000,000-gal. centrifugal pump, two 3,000,000-gal. centrifugal pumps, one wash water pump, and one switchboard and equipment. Work under (a) includes 6,000 cu.yd. excavation and 440,000 lb. reinforcing steel. S. A. Greeley, 39 West Adams St., Chicago, Ill., engineer.

Iowa

ALTA—The city has awarded the contract for the construction of a sewage disposal plant, to Ward & Weighton, 516 Davidson Bldg., Sioux City. Estimated cost, \$12,740.

AURELIA—C. H. Currie, engineer, Webster City, will receive bids until June 3 for the construction of a sanitary sewer and a sewage disposal plant. Estimated cost between \$30,000 and \$40,000.

GARNER—The city will receive bids until June 4 for the construction of a sanitary sewerage system and sewage disposal plant to include (a) disposal plant, tank, sand filters and sludge bed, (b) outlet main sewer, (c) lateral sewers, J. G. Thorne, 317 Howes Bldg., town engineer, R. V. Reed, town clerk.

POCAHONTAS—The city will soon receive bids for the construction of a sanitary sewer, septic tank and beds in practically all the streets in the city. Estimated cost, \$37,000. C. H. Currie, Webster City, engineer.

Maryland

HOMEWOOD (Baltimore, P. O.)—The trustees of Johns Hopkins University have awarded the contract for the construction of a 1-story, 50 x 150-ft. laboratory on Charles St. Ave., to Fraine Bros. & Haigley, 18 Clay St., Baltimore. Estimated cost, \$55,000. Noted May 15.

WAGNERS POINT (Baltimore P. O.)—The Mexical Petroleum Co., 1015 Security Bldg., Los Angeles, Cal., plans to build an oil refinery here. Estimated cost, \$1,000,000.

Massachusetts

CHICOPEE—The Torrington Manufacturing Co. plans to build an addition to its brass goods plant, here. Estimated cost, \$50,000.

Michigan

PONTIAC—C. W. Ham, city clerk, City Hall, will receive bids until June 9 for the construction of sewage treatment works here. C. W. Hubbell, 2348 Penobscot Bldg., Detroit, consulting engineer.

Missouri

DUENWEG—The Log Cabin Mining Co. plans to move the Old Quaker Valley mill from Riverton, Kan., and erect same at Duenweg, and is in the market for a boiler, pump and tables. O. M. Long, manager.

SCOTLAND—The High Grade Zinc Mining Co., Duenweg, Mo., plans to build a new mill here and is in the market for a hoist, rock drills and small compressor. J. W. Baker, manager.

WACO—The Tulsa-Pittsburgh Mining Co., Pittsburgh, Kan., plans to build a mill at No. 2 shaft and is in the market for equipment for same. G. O'Connor, superintendent.

Nebraska

GENEVA—The city received bids for laying sanitary sewers and installing Imhoff tank and sprinkling filters, from S. A. Connelia, Omaha, \$30,225; A. A. Dobson Co., 945 D. St., Lincoln, \$30,390; G. Vlasnik, 624 North 32nd St., Lincoln, \$31,688.

North Dakota

GRAND FORKS—The State Board of Regents has awarded the contract for installing chemical tables for new chemistry building, at the University of North Dakota, to L. Peterson, 1234 Fullerton Ave., Chicago, Ill.

New Jersey

NEWARK—The Board of Freeholders of Essex County will soon receive bids for enlarging the sewage disposal plant at Overbrook. Estimated cost, \$100,000. A. Reimer, county engineer.

TRENTON—The Atlas Tire & Rubber Co. has awarded the contract for the construction of a 1-story, 90 x 360 and 82 x 92-ft. rubber plant on Enterprise Ave., to J. H. Morris Co., 615 Broad St. Bank Bldg. Estimated cost, \$250,000.

New York

POUGHKEEPSIE—The State Hospital Commission, Capitol, Albany, will receive bids until June 4 for altering and building additions to the water supply system at the Hudson River State Hospital here. Plans include the installation of additional filters, changing the water mains and building a reservoir. L. F. Pilcher, State Architect.

SYRACUSE—The city is having plans prepared for the construction of a modern rubbish incinerator, to be operated in connection with the new garbage disposal plant, to consist of sorting sheds and furnaces. Estimated cost, \$100,000. H. C. Allen, city engineer.

WATERTOWN—The Northern Oil & Fuel Co., 469 Coffeen St., plans extensive additions to its plant; to include the installation of two 50,000-gal. oil and gasoline tanks and completely equipped testing laboratory for handling tests of gasoline, oils and greases. Address G. W. Lane, general manager.

Ohio

SALEM—The city has awarded the contract for the construction of additional filter beds, to the Jones Construction Co., Salem. Estimated cost, \$30,800.

Oklahoma

MIAMI—T. L. Green, consulting engineer, would like to receive catalogs and prices on flush tank siphons, intermittent disposal plant siphons, sludge pumps and sewerage and water filtration equipment.

Oregon

SALEM—The Valley Packing Co. has awarded the contract for the construction of a meat packing plant, to F. J. Leonard, Lewis Bldg., Portland. Project includes a 24 x 36-ft. building for rendering tanks, boiler room and fertilizer department. Total estimated cost, \$130,000.

Pennsylvania

ALLENTOWN—The city plans to build a sewage disposal plant on a 400-acre farm purchased three years ago, with a capacity sufficient to care for the entire city. It is planned to purify the sewage by a newly discovered process, which makes use of electricity and lime. Work may be done under the supervision of H. T. Bascombe, city engineer. Estimated cost, between \$3,000,000 and \$4,000,000.

BAKERTON (Elmora P. O.)—The Bakerton Water Co. has awarded the contract for the construction of a water system, to the Ambursen Construction Co., 61 Broadway, New York City, N. Y. Plans include a 30-ft. concrete dam, together with gate house, filters, etc.

BLAIRSVILLE—The Western State Hospital for Insane, Altoona, is having plans prepared by Crooks & Cooley, architects, Jones Law Bldg., Pittsburgh, for the construction of a hospital and group of institutional buildings near here, to include a sewage disposal plant, reservoir, nurses' home and morgue, etc. Total estimated cost, \$2,000,000. G. S. Idell, 34 South 16th St., Philadelphia, consulting architect.

BOYERTOWN—The School Board has awarded the contract for the construction of a 2-story high school on 4th St. between Monroe and Madison Sts., to W. J. Elliott, Coatesville. Plans include the installation of an experimental laboratory. Total estimated cost, \$115,000.

FRANKLIN—The city has purchased a site on Elk St. and plans to build a sewage disposal plant.

PITTSBURGH—The A. M. Byers Co., 235 Water St., plans to build a 36 x 72-ft. water treating and filtering plant. Estimated cost, \$35,000.

South Dakota

EAU CLAIRE (Columbia P. O.)—The Town Council plans an election soon to vote on \$40,000 bonds for the construction of a waterworks system, to include filters, pumping station, etc. W. C. McCreight, Union National Bank Bldg., Columbia, clerk.

Tennessee

CHATTANOOGA—The Calvert-Harrison Feature Picture Producing Co. has awarded the contract for the construction of a film factory and studio, to the M. K. Wilson Co., James Bldg. Estimated cost, \$50,000.

Texas

CISCO—The city has awarded the contract for the construction of two filtering plants having a daily capacity of 700,000 gal. to the National Water Purifying Co., Dallas. Estimated cost, \$25,000.

EAST WACO—The Arrow Refining Co. has purchased a site of 60 acres here and plans to build an oil refinery.

GARLAND—The Gulf Pipe Line Co. has purchased a site of 120 acres here and plans to build an oil refinery.

HOUSTON—The Columbian Refining Co. plans to build a refinery on the ship canal near here. Estimated cost, \$500,000.

LAREDO—The Texas Gulf Refining & Pipe Line Co. plans to build an oil refinery on the Texas-Mexico border here. Estimated cost, \$250,000.

SHERMAN—The Merchants & Farmers Refining Co. plans to build a refinery here. Estimated cost, \$100,000.

Washington

VANCOUVER—The Daily Clay Products Co. is having plans prepared for the construction of the first unit of its clay plant. Estimated cost, \$50,000. A. H. Haley, Vancouver, architect.

West Virginia

CLARKSBURG—The Lafayette Glass Co. has awarded the contract for rebuilding its plant, to the Memphis Steel Construction Co., Magee Bldg., Pittsburgh, Pa. Estimated cost, \$70,000. Noted May 15.

WESTON—The State Board of Control, Charleston, will receive bids until June 14 for the construction of sewage treatment works at the Weston State Hospital, here. Plans include sewage pumping station equipped with two electric motors, two centrifugal pumps and automatic control equipment, also a sewage sedimentation tank, sprinkling filter, sludge bed and chlorinating plant. J. S. Larkin, member.

British Columbia

CASSIDY—The Granby Consolidated Mining & Smelting Co., 718 Granville St., Vancouver, has awarded the contract for the construction of a washing plant here, to the Taylor Engineering Co., 550 Hastings St., W. Vancouver. Estimated cost, \$150,000.

Ontario

WELLAND—The Imperial Oil Co., 56 Church St., Toronto, has purchased a site here and plans to build a plant. Estimated cost, \$40,000.

Nova Scotia

SYDNEY—The Dominion Tar & Chemical Co. has awarded the contract for the construction of a still house, to the Sydney Foundry & Machine Co., Sydney. Estimated cost, \$30,000.

Quebec

GRAND MERE—The Laurentide Co., Ltd., McGill St. and 3rd Ave., manufacturer of paper, is receiving bids for the construction of a finishing room. Estimated cost, \$30,000. D. Wurtile, c/o owner, engineer.

Coming Meetings and Events

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its Summer meeting at Boston, Mass., June 18-21. A symposium is planned on electric furnaces.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 22nd annual meeting at Atlantic City, N. J., June 24-27. The headquarters will be at the Hotel Traymore.

THE AMERICAN ZINC INSTITUTE will hold its annual meeting at St. Louis, Mo., June 9-10.

THE FRANKLIN INSTITUTE will hold a meeting on May 21 at which the presentation of the Franklin Medal to Major-General James Douglas McLachlan on behalf of his Britannic Majesty's Government for Sir James Dewar will be given, together with the presentation of the Franklin Medal to Major-General George Owen Squier of the United States Army.

THE INTERNATIONAL CHEMICAL CONFEDERATION will hold its next meeting in London, July 15-18, 1919.

THE NATIONAL FERTILIZER ASSOCIATION will hold its 26th annual convention the week of June 23 at the Hotel Griswold, Eastern Point, New London, Conn.

THE NEW JERSEY CHEMICAL SOCIETY will hold the last meeting before the Summer, Monday evening, June 9, 1919, in Newark, N. J.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its 27th annual meeting at Johns Hopkins University, Baltimore, Md., June 25-28.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its Spring meeting at Erie, Pa., and Buffalo, N. Y., June 11-14 inclusive.

Industrial Notes

THE GELLERT ENGINEERING CO., Philadelphia, Pa., is now erecting electrical precipitators which are being installed at the plant of the American Manganese Manufacturing Co., at Dunbar, Pa., to clean the gases from the blast furnaces. They are expected to be completed by June 1.

THE UNITED STATES & CUBAN ALLIED WORKS ENGINEERING CORP., New York City, announces that Mr. J. A. King has become identified with it as works manager and will be in charge of the corporation's plant, foundry, machine shop and structural works at Havana, the Havana Iron Works, and the marine works, the Havana Dry Dock Co. It is also announced that Mr. Emile J. Bayle has joined the corporation as sales manager.

THE HUFF ELECTROSTATIC SEPARATOR CO., which has been located for the last fourteen years at 60 India Street, Boston, Mass., has recently acquired and fitted up a large plant at Arlington, Mass., a suburb of Boston, to which it has moved its offices, ore-testing and chemical laboratories and works. It maintains a well-equipped laboratory for the purpose of making either preliminary or complete tests showing the results that can be obtained commercially in the separation or concentration of minerals, abrasive materials, and reclaiming valuable content of many waste materials by the Huff Electrostatic process. Mr. H. B. Johnson, an expert on graphite refining, is general manager of the company.

THE ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, reports the successful starting up of a Greaves-Etchells electric furnace at the plant of the Davidson Tool Manufacturing Corp., Brooklyn. This furnace is used in conjunction with Mr. Davidson's special process for the manufacture of high speed steel castings. Remarkable results have been achieved in the manufacture of high speed steel cutters, drills, boring tools, etc. The company also reports the starting up of a 6-ton furnace at the Navy Department, Mare Island, in England. Greaves-Etchells furnaces have been started up for the Tyne Electrical Steel Foundries, Ltd., for the manufacture of steel castings; and a special 6-ton furnace has been installed for W. W. McGregor, of Airdrie, for the manufacture of alundum.

THE MERRILL CO., San Francisco, Cal., is the successor to the Merrill Metallurgical Co., taking over the patents and commercial business of its predecessor. It expects to continue to enlarge its scope as new devices and products become available.

THE BAILEY METER CO. moved its main office and works from Boston to Cleveland, Ohio, on May 1. The Boston office, with Mr. H. D. Fisher, as manager, is retained to handle sales and engineering service work in the New England district. For the present New York and Philadelphia districts will be covered from Boston and all other districts will be covered from Cleveland.

THE OLIVER CONTINUOUS FILTER CO., San Francisco, states that conditions in Mexico are becoming more stable and that metallurgical companies are resuming operations. The American Smelters Securities Co., for example, has recently purchased for the Veta Grande mill at Parral, Chihuahua, six 12-ft. diameter by 16-ft. Oliver filters with complete vacuum equipment. The mill capacity is being increased to 600 tons daily. Sales of similar equipment have been made to the Benguet Consolidated Mines in Benguet, Philippine Islands, and to the Government cyanide plant in the Dutch East Indies.

THE ASSOCIATION OF MEMBERS OF AMERICAN NATIONAL ENGINEERING SOCIETIES IN CUBA was organized in Havana, on Feb. 21, 1919, to foster the interests of the various national engineering societies represented on the island. Membership is restricted to persons who are members of the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the American Society of Agricultural Engineers, the American Society of Refrigerating Engineers, the Mining and Metallurgical Society of America, the American Institute of Architects, the American Iron and Steel Institute, the American Chemical Society and such other societies as may from time to time be added to the list by the board of directors. It is planned to hold four regular meetings each year for the reading and discussion of papers.

Manufacturers' Catalogs

THE NORTON CO., Worcester, Mass., has issued its 1919 edition of Norton Refractories. This attractive 60-page bulletin is a complete revision of the previous catalog, and contains many additions, including an extensive range of sizes of tubes, muffles and cores, as well as newly developed shapes and a new product known as "electrically sintered magnesite." Prices are given of the various products and also illustrations. A number of tables and charts and a complete bibliography of alundum and crystalline refractories have been completed, which makes it useful as a reference book in connection with high temperature electric furnace products.

THE PYROELECTRIC INSTRUMENT CO., Trenton, N. J., has just issued Bull. No. 3, dated April 1919, which gives in four pages illustrations and descriptive matter on the production of carbon free alloys of high melting point. Circular No. 15 deals with continuously deflecting Northrup pyrometer and pyrometer which contains circuits for checking its indications.

Stocks and Bonds

Closing Bid and Asked Quotations May 27, on N. Y. Stock Exchange

CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am. Ag. Ch.	109 1/2	109 3/4	Mat. Al. Wk.	31	40
do. pf.	100 1/2	101	Ten. C. & C.	14 1/2	15
Barrett Co.	134 1/2	135	Un. Dyewood	61	63
do. pf.	117	120	do. pf.		96
Gen. Chem.	190	199	Va.-Car. Ch.	73	73 1/2
do. pf.	102 1/2	103 1/2	do. pf.	13 1/2	13 1/2
Int. Ag. Ch.	26	27			
do. pf.	85	85 1/2			

Bonds

Am. Ag. Ch., 1st cv. 5s, '28	100	101
Am. Ag. Ch., cv. db. 5s, '24	106	110
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32	82 1/2	83
Va.-Car. Ch., 1 mtg. 5s, '23	97	97 1/2
Va.-Car. Ch., cv. db. 6s, '24	101 1/2	102 1/2

PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co.	90 1/2	90 3/4	P-A Pet & Tr.	94 1/2	94 3/4
Cal. Pet.	32	32 1/2	do. pf.	160	166
do. pf.	79 1/2	80	Pierce Oil	26 1/2	26 3/4
Col. G. & E.	52 1/2	52 3/4	Royal Dutch	115 1/2	116 1/2
Mex. Pet.	182 1/2	183 1/2	Sinclair O & R	68	68 1/2
do. pf.	108 1/2	108 3/4	Texas Co.	178	179
Ohio Cit. Gas.	54 1/2	54 3/4	Tex. Pac. Ld.		
do. pf.			Tr.	400	600
Ohio Fuel S.	50	51	Tidewater Oil	248	250
Okla. P. & R.	11 1/2	12			

Bonds

Columbia Gas & Electric, 1 5s, '27	87	89
Col. G. & E., std. 1 5s, '27	86 1/2	87
Pan-Am. Pet. & Tr. 1 5s, '19-'27	150	
Pierce Oil, cv. db. 6s, '24	132	142
Pierce Oil, cv. 5s, Notes, '20	109 1/2	109 3/4
Sin. O. & R. 1 In. 7s, '20, with stk. war.	146	151
Sin. O. & R. 1 In. 7s, '20 without stk. war.	99 1/2	100
Texas Co., db. 6s, '31	102	102 1/2
Union Oil of Cal. 1 5s, '31	93 1/2	94 1/2
United Fuel Gas 1 mtg. 6s, ser. A, '36	95 1/2	97

IRON AND STEEL SECURITIES

	Bid	Ask		Bid	Ask
Am. St. F.	37 1/2	37 3/4	Pitts. Ste. pf.	90	90 1/2
Beth. Steel	79	80 1/2	Rep. Iron & Steel	87 1/2	88 1/2
do. class B	79 1/2	79 3/4	do. pf.	104	104 1/2
do. pf.	112 1/2	112 3/4	Sloss Sheff. I.	63	64
do. pf. 7s	160	165	& S.	90	91 1/2
Central Fdry.	23 1/2	24	do. pf.	49 1/2	50
do. pf.	48 1/2	49 1/2	Superior Steel	99 1/2	101
Col. F. & I.	47 1/2	47 3/4	do. 1 pf.		
do. pf.	105 1/2	120	Trans. & W.		
Crus. Steel	80 1/2	81	Steel	56	57 1/2
do. pf.	98	100	Un. Alloy St.	53 1/2	54 1/2
Great No. Ore	47	47 1/2	U.S.C.I.P. & F.	25 1/2	26
Gulf Sta. Steel	73 1/2	74	do. pf.	63	64 1/2
do. 1 pf.	93	98	U. S. Steel	107 1/2	107 3/4
Lack. Steel	83 1/2	84	do. pf.	115 1/2	115 3/4
Mid. St. & Ord.	51 1/2	51 3/4	Va. Coal, I. & C.	67	68
Nova Scotia Steel	73	74			

Bonds

Beth. Steel, 1 ext. gtd. S. F. 5s, '26	96	96 1/2
Beth. Steel, 1 In. ref. 5s, Ser. A, '42	89 1/2	90
Beth. Steel, P. M. & I. S. F. 5s, '36	86 1/2	87
Buff. & Susq. Iron, 1 S. F. 5s, '32	91	96
Buff. & Susq. Iron, deb. 5s, '27	80	81
Cent. Found. 1 mtg. S. F. 6s, '21	91	93 1/2
Col. F. & I., gn. S. F. 5s, '45	85 1/2	87
Ill. Steel, db. 4 1/2s, '40	97 1/2	98
Ind. Steel, 1 mtg. gtd. 5s, '32	96 1/2	97 1/2
Lack. Steel, 1 5s, '23	92 1/2	94 1/2
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50	89 1/2	89 3/4
Mid. St. & Ord., elt. cv. S. F. 5s, '36	92 1/2	89 1/2
Nat. Tube, 1 mtg. gtd. 5s, '32	97 1/2	99
Rep. I. & S. S. F. 5s, '40	96	98
Tenn. C. & I. R. R., gn. 5s, '31	91 1/2	95 1/2
U. S. Steel, S. F. 5s, '63	100	100 1/2
Va. C., I. & C., 1 5s, '49	85 1/2	88 1/2